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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
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The Secretary of the Interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 30, 1985.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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THE WATER RESOURCES SCIENTIFIC INFORMATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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03 WATER SUPPLY AUGMENTATION AND CONSERVATION

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04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

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2. WATER CYCLE

2A. General

SIMULATION OF HERBICIDE CONCENTRATIONS IN STORMFLOW FROM FORESTED WATERSHEDS,
Georgia Univ., Athens. School of Forest Resources.
W. L. Nutter, T. Tkacs, P. B. Bush, and D. G. Neary.
Water Resources Bulletin, Vol. 20, No. 6, p 851-857, December, 1984. 5 Fig, 2 Tab, 24 Ref.

Descriptors: *Herbicides, *Forest watersheds, *Stormflow, *Runoff, *Path of pollutants, *Watershed models, Model studies, Hexazinone, Bromacil, Picloram, Dicamba, Triclopyr, Erosion.

The breakpoint rainfall hydrology and pesticide options of the field scale model CREAMS (Chemicals, Runoff, and Erosion from Agricultural Managemant Systems) were used to predict average concentrations of hexazinone (3 cyclohexyl-6-(dimethyl-amino)-1-methyl-1,3,5-triazine-2,4(1H,3H)-dione) in stormflow from four forested watersheds in the upper Piedmont region of Georgia. Predicted concentrations were compared with measured concentrations recorded over a 13-month period. CREAMS accurately predicted hexazinone concentrations in the initial stormflow events which also contained the highest concentrations. The model underestimated the hexazinone concentrations in stormflow two months and greater following pesticide application. In a companion study, the daily rainfall option of the CREAMS model was used to evaluate the relative risk associated with the maximum expected concentration of hexazinone, bromacil (5-bromo-3 sec-butyl-6 methyuracil), picloram (4-amino-3,5,6 trichloropicolinic acid), dicamba (3,6-dichloro-0-anisic acid), and triclopyr (((3,5,6-trichloro-2-pyridinyl)oxy)acetic acid) in stormflow from small forested watersheds. The model predicted the following order of potential residue appearance in stormflow: bromacil > triclopyr > hexazinone > picloram > dicamba. Subsurface movement of residues via interflow and deep leaching losses are not simulated by the version of CREAMS used in these studies. (Author's abstract)
W85-04991

HYDROLOGY IN TROPICAL AUSTRALIA AND PAPUA NEW GUINEA,
Bureau of Meteorology, Melbourne (Australia). Hydrometeorology Branch.
A. J. Hall.
Hydrological Sciences Journal, Vol. 29, No. 4, p 399- 423, December, 1984. 8 Fig, 56 Ref.

Descriptors: *Australia, *Papua New Guinea, *Hydrology, *Climatology, *Tropic zones, Intertropical convergence zone, Streamflow, Runoff, Rainfall, Seasonal variation.

Australia is a continent of climatologic contrasts with one of the most variable rainfall and runoff regimes in the world. One of the world's wettest and least variable regimes is in Papua New Guinea (PNG) which is well within the equatorial humid tropical region. Australia and PNG provide considerable contrasts hydrologically. PNG lies within the seasonal movement of the intertropical convergence zone and by and large has a comparatively uniform rainfall throughout the year. Convective rainfall in PNG has wide spatial variation under the influence of one of the world's larger cordilleras. The Australian tropical region has one wet season, for about four months of the year, and is subject to extreme variability of rainfall associated with the presence, or absence, of tropical cyclones. This is particularly the case in the northwest where heavy rainfall associated with cyclones occurs less frequently. While annual streamflows in PNG are reliable by world standards and relatively short records can provide reasonable design data for monthly and annual flows, Australia has streams which are considerably more variable than world rivers. Relative to mean annual runoff, Australian mean peak annual floods can be up to an order of magnitude larger than world rivers and the variability of peak annual floods is larger. Flood design in PNG based on streamflow and regional flood frequency methods is preferred to attempts to relate storm rainfall to runoff. Despite the areal variation in storm rainfall, good simulations of daily discharges have been made using conceptual rainfall-runoff models. The status of hydrology in the region has overall reached a reasonable level condidering the sparse settlement of northern Australia and the extreme ruggedness of PNG and its level of development. (Collier-IVI)
W85-05005

PROPOSAL TO CONSTRUCT A COORDINATING MATRIX FOR COMPARATIVE HYDROLOGY,
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 7A.
W85-05007

STUDIES ON DROUGHTS OF TAMIL NADU WITH SPECIAL REFERENCE TO THEIR SPREAD AND SEVERITY,
Cochin Univ. (India). Dept. of Marine Sciences.
For primary bibliographic entry see Field 2B.
W85-05073

WGEN: A MODEL FOR GENERATING DAILY WEATHER VARIABLES,
Agricultural Research Service, Washington, DC.
For primary bibliographic entry see Field 7C.
W85-05129

STATISTICAL MODELING OF INTERDEPENDENT ARTIFICIAL HYDROLOGIC SERIES WITH A NONSYMMETRIC GAMMA CORRELATION,
M. A. Velikanov.
Water Resources, Vol. 11, No. 1, p 77-84, January-February, 1984. 2 Tab, 8 Ref. Translated from Vodnye Resursy, No. 1, p 122-130, January-February, 1984.

Descriptors: *Hydrologic models, *Statistical models, Mathematical studies, Water management, Probability, Water managment, Flow discharge, Runoff.

A group of interdependent artificial hydrologic series with given probabilistic characteristics must be obtained when planning water management and water power systems. The accuracy of the hydrologic and water management calculations must be established and the probabilistic limits of variations of the output of the regulating plants determined. The problem of obtaining interdependent artificial series with an autocorrelation, each of which obeys a two-parameter gamma distribution is considered. As an example the results of combined modeling of the mean annual water discharges at three sites are given: Syr Darya at Bejovat city, Irtysh at Ablaketka village, and Ob at Kamen-on-Ob city. A statistical analysis of the data of long term hydrometric observations at these sites showed that each series of mean annual discharges can be described by a two-parameter gamma distribution. A method is proposed which broadens the possibilities of a mathematical description of the process of runoff variations of rivers. When solving particular water management and water power problems, this makes it possible to select those models which best agree with the data from on-site measurements. For this purpose regression relationships reflecting the character and form of intra- and interseries relations of the artificial hydrologic series obtained are presented. This makes is possible, without proceeding to modeling of artificial series, to estimate how the theoretical regressions of these series agree with the available data. If the comparison shows that there is such an agreement, then artificial series obtained by the given algorithms reflect well all regularities of the investigated process of runoff variations at several sites. (Baker-IVI)
W85-05149

MODELING OF TOTAL ACID PRECIPITATION IMPACTS.
For primary bibliographic entry see Field 5C.
W85-05313

NORWEGIAN MODELS FOR SURFACE CHEMISTRY: AN OVERVIEW,
Norsk Inst. for Vannforskning, Oslo.
R. F. Wright.
In: Modeling of Total Acid Precipitation Impacts. 1984. p 73-87, 7 Fig, 2 Tab, 18 Ref.

Descriptors: *Model studies, *Lakes, Hydrologic models, *Acidification, *Chemical properties, *Hydrogen ion concentration, *Acidic water, Reviews, Minerals, Sulfates, Acids, Simulation analysis, Theoretical analysis.

The Henriksen's empirical model for lake acidification and the Birkenes model for streamwater chemistry are reviewed. Henriksen's empirical model for lake acidificaiton is based on the hypothesis that acidification can be described as a large-scale titration in which bicarbonate solution is titrated with a strong acid. This simple model estimates the pH of Norwegian lakes down to levels of 5.0. The Birkenes model simulates the chemical properties of lake water at specific sites on a day-to day basis. It can simulate the pH of stream water given only the precipitation volume, sulfate concentration, dry deposition of S, and temperature. The hydrologic and sulfate parts of the Birkenes model have been successfully applied to the Storgama gauged catchment. Both the Henriksen and Birkenes models are static with respect to long time periods and present some drawbacks when used for prognosis.
W85-05317

MODELING THE REACIDIFICATION RATES OF NEUTRALIZED LAKES NEAR SUDBURY, ONTARIO,
Ontario Ministry of the Environment, Rexdale. Water Resources Branch.
P. J. Dillon, and W. A. Scheider.
In: Modeling of Total Acid Precipitation Impacts. 1984. p 121-154, 6 Fig, 17 Tab, 39 Ref.

Descriptors: *Acidification, *Neutralization, *Model studies, *Hydrologic models, *Lakes, *Acidic water, *Hydrogen ion concentration, Acids, Bases, Watershed models, Chemical properties, Alkalinity, Acid rain, Lake sediments, Nitrogen, Phosphorus, Ontario, Lake Hannah, Lake Middle, Lake Lohi, Lake Clearwater.

The hydrological budgets, input of materials by bulk deposition and the material budgets for the watershed of four lakes near Sudbury, Ontario were combined and used with a mass balance model to predict the reacidification rate of the neutralized lakes. Lake water, sediment, precipitation and stream input samples to Lakes Hannah, Middle, Lohi, and Clearwater were tested regularly from 1973 to 1979. Predictions based on the mass balance model indicated that Lohi Lake would reacidify in late 1976. Reacidification occurred only 6 to 9 months later. The alkalinity of Lohi Lake stabilized at values greater than predicted, indicating that there was an unmeasured internal generation of acid neutralizing capacity (ANC) or that the inputs of mineral acidity were overestimated. The measured ANC in Middle and Hannah lakes was always much greater than ANC predicted by the mass balance model. ANC supplied by nitrate uptake by the biota following fertilization could not account for all the extra ANC generated in these two lakes. It was hypothesized that the remainder of the ANC was released from sediments that had been previously neutralized. The pH of Clearwater Lake will not increase unless the mineral acidity input is reduced.
W85-05319

MODELING IMPACTS OF ACID PRECIPITATION FOR NORTHEASTERN MINNESOTA,
Iowa Univ., Iowa City. Div. of Energy Engineering.
For primary bibliographic entry see Field 2K.
W85-05320

Group 2A—General

U. S./ CANADA AQUATIC IMPACTS ASSESSMENT: INTEGRATION OF EXPERIMENTAL STUDIES, MONITORING AND MODELING OF ACIDIC DEPOSITION EFFECTS,
Institute of Ecology, Indianapolis, IN.
O. L. Loucks, and G. E. Glass.
In: Modeling of Total Acid Precipitation Impacts. 1984. p 205-217, 3 Fig, 3 Tab, 30 Ref.

Descriptors: *Model studies, *Acidification, *Acid rain, *Hydrologic models, *Ecosystems, Sulfates, Nitrates, Hydrogen ion concentration, Chemical properties, Air pollution, Soil chemistry, Northeastern United States, Water pollution sources, Water quality, Minerals.

The use of both qualitative comprehensive models and quantitative empirical models as methodologies for the aquatic impact assessment process in Phases I and II of the 1980 U. S./Canada Memorandum of Intent on long-distance pollutants was evaluated. The major components of an applications-oriented systems model are distribution and variability of the input driving variables, processes in the responding system and observed response relations, quantification of biological response relationships, and quantification of predictive/summarative models. The three most suceptible regions for acidification in the eastern half of the U. S., based on the acid-neutralizing constituents of bedrock and soils, are the Northeast, the Appalachian Mountain regions, and the Minnesota-Wisconsin-Michigan highlands. High sulfate concentrations in these regions of low Ca and Mg in soils and waters leads to greatly depressed concentrations of bicarbonate alkalinity. Empirical models have been used to predict sulfate loadings and tolerances of aquatic ecosystems. Mechanistic models for more quantitative evaluations will require more rigorous methodologies such as sequential hypothesis testing.
W85-05322

AGRICULTURAL DROUGHT ASSESSMENTS USING A CROP MODEL.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
Available from the National Technical Information Service, Springfield, VA 22161. Final Report: October 1, 1980 - July 31, 1983. July 1983. 154 p, 28 Fig, 58 Tab, 44 Ref, 6 Append. Contract/Grant No. 1-07-81-V0159.

Descriptors: *Model studies, *Drought, *Simulation analysis, Wheat, Sorghum, *Soil water, *Mathematical models, Crop yield, Evapotranspiration, Precipitation, Palmer drought index, Texas, Kansas, Plant growth, *Soil-water-plant relationships, Drought prediction, Prediction.

Grain sorghum and winter wheat crop growth simulation models were analyzed to determine the ability to make agricultural drought assessments. Model simulations were run for 30 sorghum seasons and 29 wheat seasons at Temple, Amarillo, and Lubbock, Texas and Manhattan, Kansas. Regression equations were developed at various times in the season between within-season modeled soil water and modeled yield. Early prediction (i.e., before flowering) of yield using the soil water regression equations had errors of approximately 40-60% of mean modeled yield at a location. For sorghum, an additional forecasting technique was developed which involved running-out the model at selected times using weather scenarios to obtain a distribution of simulated yields. Predictive capabilities were not substantially improved with this technique. To further test the validity of the models, modeled yields were compared with USDA county and crop reporting district yields, performance test yields, and monthly Palmer Drought Index values. Correlations were poor between modeled yield and other independent yield data. A methodology using crop models for assessment of status quo crop conditions and forecasting future developments has been developed. The poor results are likely due to inadequacies in the current models and with model improvements, results are likely to improve. (Author's abstract)
W85-05332

HYDROLOGIC AND WATER QUALITY MODELS FOR AGRICULTURE AND FORESTRY.
Virginia Polytechnic Inst. and State Univ., Blacksburg.
Research Bulletin No. 291, Southern Regional Association of State Agricultural Experiment Stations, June 1983. Edited by M. D. Smolen. 104 p. 2 Append. Project S-108.

Descriptors: *Models, *Hydrologic models, *Mathematical models, *Computer models, *Watershed management, *Agricultural watersheds, *Forest watersheds, *Water quality, Model studies, Regression analysis, Rural areas, Mathematical studies, Sediment transport, Crop yield, Erosion, Solute transport, Rainfall-runoff relationships.

This report resulted from the Cooperative Research Project S-108, which was active from 1976 to 1980, and aimed to develop models to simulate the hydrologic transport processes of rural watersheds. The S-108 committee considered models covering a wide range of conceptual and computational approaches and arranged them for easy comparison by potential users. Most of the models considered in this project were from three distinct conceptual types: the regression model, the lumped parameter model, and the distributed parameter model. In presenting each model, the authors have attempted to use examples that relate to a common watershed, Crab Creek Watershed in Montgomery County, Virginia. The models have varying capabilities for simulating water quality. A substantial effort was directed toward the detailed study of components of the hydrologic cycle. Five watershed models and four other models dealing with solute transport, rainfall partitioning, and tillage and erosion effects on crop yield are presented along with hydrologic data on Crab Creek Watershed and a list of publications resulting from Regional Project S-109.
W85-05338

NORTH CAROLINA STREAMFLOW SYNTHESIS AND RESERVOIR REGULATION MODEL,
E. H. Wiser.
In: Research Bulletin No. 291, Southern Regional Association of State Agricultural Experiment Stations, June 1983. Edited by M. D. Smolen, p 7-18, 1 Fig, 9 Tab, 6 Ref. Project No. S-108.

Descriptors: *Hydrologic models, *Model studies, *Streamflow, *Reservoir operation, *Simulation analysis, *Mathematical models, *Computer models, *Streamflow forecasting, Watershed management, Models, Mathematical studies, Watersheds, Precipitation, Cost analysis.

The North Carolina version of the Streamflow Synthesis and Reservoir Regulation model (NCSSARR) is a system that was developed to simulate watershed streamflow in any region of the country. The system is interfaced with the Hydrologic Information Storage and Retrieval System and has been used on large complex river basins. The NCSSARR watershed model uses only daily precipitation data and removes snowmelt subroutines. The NCSSARR watershed model was tested on Crab Creek and Bush Creek in Virginia. A North Carolina watershed was used to provide parameters for simulation of streamflow by adjusting the weight used for the climatological stations to 0.66 for Crab Creek and 1.00 for Bush Creek. Results were suprisingly good for the two simulations, considering that only the mean flow was fitted. Simulation of 10 yr of data for the Crab Creek watershed on an Amdahl 470/V8 computer required 242 K of core memory and took 46 sec of chargeable time at a cost of $1.91. Evaluation of test statistics took an additional 40 sec at a cost of $1.55.
W85-05339

USDAHL HYDROLOGIC MODEL,
K. L. Campbell, Yaramanoglu, and F. R. Crow.
In: Research Bulletin No. 291, Southern Regional Association of State Agricultural Experiment Stations, June 1983. Edited by M. D. Smolen, p 19-32, 1 Fig, 5 Tab, 8 Ref. Project No. S-108.

Descriptors: *Model studies, *Hydrologic models, *Computer models, *Agricultural watersheds, *Water yield, *Watershed management, *Infiltration, *Runoff, *Simulation analysis, Mathematical models, Precipitation, Evapotranspiration, Models, Soil profiles, Cost analysis.

The USDAHL-74 Revised Model of Watershed Hydrology is a deterministic, semiempirical, lumped parameter hydrologic model designed to predict runoff and infiltration in relatively small agricultural watersheds under natural rainfall conditions. The model consists of surface and a subsurface flow component and can predict annual and monthly water yields with a reasonable degree of accuracy. The model requires about 72 different input parameters in addition to meteorological data. This input data is of four types: watershed, soils, land use and hydraulic data. The evapotranspiration parameter plays an important role in model accuracy. The accuracy of soil characteristic parameters also greatly affects model performance. The USDAHL model was used to simulate the hydrology of Crab Creek Watershed, Virginia using meteorological input data from 1965. The storm event from August 21, 1966 was also simulated in detail to compare with the observed hydrograph. Although the runoff volume was simulated accurately, the hydrograph shape and peak runoff rate were greatly different. The USDAHL model assumes uniform spatial distributions of precipitation, an assumption which may not be accurate for larger watersheds. Since the model accepts precipitation input from only one station, inaccuracies may occur. These can be minimized by averaging rainfall records from a number of gages within the watershed. The USDAHL model can readily accomodate water quality model components. Simulation of the hydrology of a 1600-acre watershed for a 3-yr period cost $5.24 including $2.70 for printing with a CPU time of 17.43 sec.
W85-05340

SEDLAB: THE HYDROLOGY/SEDIMENT TRANSPORT MODEL OF THE USDA SEDIMENTATION LABORATORY,
E. H. Seely.
In: Research Bulletin, No. 291, Southern Regional Association of State Agricultural Experiment Stations, June 1983. Edited by M. D. Smolen, p 33-45, 3 Fig, 4 Tab, 8 Ref. Project No. S-108.

Descriptors: *Hydrologic models, *Sediment transport, *Surface runoff, *Channel flow, *Overland flow, *Computer models, *Erosion, *Agricultural watersheds, Model studies, Runoff, Watershed management, Mathematical models, Sedimentation, Simulation analysis, Models, Catchment areas, Cost analysis.

SEDLAB is a single event, distributed parameter, mathematical model which simulates surface runoff and sediment transport on small catchments. The model uses the kinematic-wave approximation for routing overland flow and channel flow to a watershed represented by flow planes and channel segments. SEDLAB consists of two linked submodels; one describes the catchment hydrology and the other describes the associated erosion and sedimentation processes. Sediment routing is accomplished by applying a continuity equation for conservation with equations for transport and soil detachment. Measured runoff and sediment data from watershed R-5 near Chickasha, Oklahoma and watershed W-5 near Holly Springs, Mississippi were used to check model accuracy. Costs for running the simulation which took 137 seconds of CPU time for a 4.56 sg km watershed ranged from $2.00 to $4.00. Many improvements in components which have already been made as a part of the small watershed model (SWM) development program can be readily incorporated into the existing model.
W85-05341

ANSWERS MODEL,
D. B. Beasley.
In: Research Bulletin No. 291, Southern Regional Association of State Agricultural Experiment Sta-

tions, June 1983. Edited by M. D. Smolen, p 46-59, 4 Fig, 13 Ref. Project No. S-108.

Descriptors: *Agricultural watersheds, *Computer models, *Sediment transport, *Erosion, *Land management, *Hydrologic models, *Water pollution sources, Watershed management, Models, Model studies, Channel flow, Subsurface drainage, Nonpoint pollution sources, Land use, Simulation anlysis, Cost analysis, Fate of pollutants, Path of pollutants.

The ANSWERS (Areal Nonpoint Source Watershed Environment Response Simulation) program is an event-oriented, distributed parameter watershed model that has been used since 1976. The updated model includes algorithms for channel flow, subsurface drainage, sediment detachment and transport (erosion and deposition) and land use and management interactions. ANSWERS was designed primarily for use in planning and evaluating strategies for the control of nonpoint source pollution from intensively cropped areas. A watershed to be modeled is assumed to be composed of elements. Elements are areas within which all hydrologically significant parameters are uniform. The input into the ANSWERS model consists of watershed topography, drainage networks, channel flow and infiltration data, precipitation data, soils, land uses and BMPs. Several graphical plotting programs have been designed to provide visual enhancement and better understanding of the ANSWERS model. The ANSWERS model has been used in a number of planning, research and teaching applications. An ANSWER simulation on a 1964 ha watershed took 8 hr and cost about $15.00 on the Purdue University computer.
W85-05342

FINITE ELEMENT STORM HYDROGRAPH MODEL,
M. D. Smolen, B. B. Ross, and V. O. Shanholtz.
In: Research Bulletin No. 291, Southern Regional Association of State Agricultural Experiment Stations, June 1983. Edited by M. D. Smolen, p 60-71, 5 Fig, 2 Tab, 17 Ref. Project No. S-108.

Descriptors: *Models, *Hydrologic models, *Runoff, *Sediment transport, *Streamflow, *Water pollution sources, *Computer models, *Hydrographs, Model studies, Nonpoint pollution sources, Simulation analysis, Watersheds, Mathematical models, Infiltration, Storm runoff, Spatial distribution, Overland flow, Channel flow.

The Finite Element Storm Hydrograph model (FESHM) is a single event, hydrologic model that simulates runoff and streamflow in an ungaged watershed. It is based on physical principles and uses a flexible distributed parameter structure to account for the spatial variability of watershed characteristics. The FESHM uses irregular boundaries typical of soil surveys and land use maps, to define the spatial range of model parameters. The fundamental concept of the FESHM is that the complex watershed system can be subdivided into less complex subsets. FESHM uses two discretization schemes to account for spatial variation; one for variations in infiltration capacity and one for variations in topography. The distributed parameter structure of the model and its high degree of flexibility make it suitable for the simulation of nonpoint pollution. Model components consist of an infiltration model, a depression storage algorithm, a finite element system for routing overland and channel flows and a sediment detachment and transport algorithm. The FESHM was less costly to use than similar simple lumped parameter models.
W85-05343

SIMPLIFIED METHOD FOR APPROXIMATING SUBSURFACE TRAVEL TIMES FOR SOLUTES IN WATERSHEDS,
R. S. Mansell.
In: Research Bulletin No. 291, Southern Regional Association of State Agricultural Experiment Stations, June 1983. Edited by M. D. Smolen, p 74-83, 3 Fig, 14 Ref. Project No. S-108.

Descriptors: *Storm seepage, *Solute transport, *Models, *Agricultural, *Mathematical models, *Surface runoff, *Water quality, *Hydrologic models, Model studies, Watersheds, Runoff, Nonpoint pollution sources, Streamflow, Mathematical studies, Simulation analysis.

A simplified mathematical model is proposed to provide conceptual insight into the major physical processes which control solute transport during subsurface water flow in small watersheds which receive periodic applications of fertilizer of secondary-treated municipal wastewater. The model involves estimating solute travel time when water flow is assumed to be steady so that streamlines can be used to distinguish pathways for solute movement through the soil. The solute molecules are assumed to travel by piston-type displacement along individual stream tubes. The stream tubes are vertical through the water-saturated soil but are curvilinear toward the drain in the saturated groundwater zone. The average concentration of solute in the subsurface flow reaching the stream changes with time due to the distribution of solute travel time in the watershed soil. The model is best suited for the simulation of subsurface flow from low-intensity rain events that do not generate surface runoff. Equations are given for a simplified method to approximate the travel time function for the saturated rectangular zone for use when the distance between the catchment boundary and a stream is greater than about 5 times the depth to the impermeable layer. If a nutrient such as NO3-N is applied uniformly to the watershed, the travel times for subsurface flow become progressively larger with increasing distance from the stream. Such models based on soil physics provide a starting point for the development of a new generation of watershed-scale water quality models.
W85-05344

PARTITIONING VARIABLE STORMS TO RAINFALL EXCESS AND SOIL WATER,
A. W. Thomas, and R. R. Bruce.
In: Research Bulletin No. 291, Southern Regional Association of State Agricultural Experiment Stations, June 1983. Edited by M.D. Smolen, p 85-89, 15 Ref. Project No. S-108.

Descriptors: *Model studies, *Rainfall, *Mathematical models, *Soil water, *Surface runoff, *Soil horizons, *Infiltration, *Hydrologic models, Models, Precipitation, Watersheds, Runoff, Soil profiles, Permeability coefficient, Storm runoff.

Three general modeling approaches for partitioning rainfall are discussed, along with their strengths and limitations. The model developed by Thomas et al. (1981) was a mathematical structure for partitioning rainfall into daily runoff and soil water on a heterogeneous landscape utilizing a retention function driven by rainfall and rescaled pan evaporation between rain events. This approach allowed the description of the state of the watershed in terms of dryness rather than the customary state of wetness. This model was used to simulate 3 yr of measured surface runoff and soil-water data from a 1.3 ha watershed having a cover of common burmudagrass. Annual summaries and seasonal patterns of measured and predicted water qualities indicated that the model could partition rainfall into runoff and soil water. Bruce et al. (1976) used a flow-theory infiltration model to examine the effects of nature and extent of horizons in soil profiles on infiltration and soil-water distribution. It was found with this model that hydraulic conductivity can be satisfactorily calculated from water retention data obtained from core samples of soil horizon material. The flow theory infiltration model used by Bruce et al. (1976) has been modified to increase versatility such as partitioning variable storm patterns. The revised model has been used to describe the effects of variable rainfall patterns and different time increments of rainfall input on rainfall excess and soil water fluxes.
W85-05345

ENVIRONMENTAL DATA SUMMARY FOR THE RHODE RIVER ECOSYSTEM (1970-1978), SECTION A: LONG TERM PHYSICAL/CHEMICAL DATA, PART 1: AIRSHED AND WATERSHED.
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
For primary bibliographic entry see Field 2L.
W85-05353

SEASONAL AND YEARLY VARIATION IN METEOROLOGICAL PARAMETERS AT THE CHESAPEAKE BAY CENTER FOR ENVIRONMENTAL STUDIES,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
D. Higman, and D. L. Correll.
In: Environmental Data Summary for the Rhode River Ecosystem (1970-1978), Section A: Long Term Physical/Chemical Data, Part 1: Airshed and Watershed, 1982. p 1-159, 34 Fig, 8 Tab, 1 Ref.

Descriptors: *Baseline studies, *Maryland, *Meteorological data collections, Data collections, Rainfall, *Precipitation, Seasonal variation, *Chesapeake Bay, *Baltimore harbor, Hydrologic data collections, Relative humidity, Evaporation, Air temperature, Solar radiation.

Readily available macroclimatic data for the Chesapeake Bay Center for Environmental Studies which show the seasonal and yearly variation in meteorological parameters are summarized. A weather station has been maintained at the site since July 1967. Prior to this data was collected from the Baltimore harbor area about 40 km north of the Center's weather station by the Naval Academy. A summary of 7 yr of solar insolation data is given. Mean monthly total insolation varies from 4,646 g cal/sq cm in December to 16,314 g cal/sq cm in July, and mean total yearly insolation was about 127,000 g cal/sq cm. A 10 yr summary of rainfall data is given. No pronounced seasonality of rainfall is apparent from these data. Mean daily maximum relative humidity for the years 1973-1977 ranged from a low 89.8% in January to a high of 97.7% in August. Evaporation rates were highest (0.58 cm/day) in July. For air temperature, the 10-yr monthly mean maxima ranged from 4.7 degrees for January to 29.5 degrees for July while the 10-yr monthly mean minima ranged from -5.4 degrees for January to 18.2 degrees for July. A statistical summary for 160-yr of rainfall data is given by month, season, and entire year. Mean precipitation was highest in August and least in November, but the monthly means and the seasonal means are grouped within a fairly narrow range and the variances are high. A statistical summary of 155 yr of mean daily air temperature and of 88 yr of daily maximum and minimum air temperature is also given.
W85-05354

NUTRIENT COMPOSITION OF THE SOILS OF THREE SINGLE-LAND-USE RHODE RIVER WATERSHEDS,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
D. L. Correll.
In: Environmental Data Summary for the Rhode River Ecosystem (1970-1978), Section A: Long Term Physical/Chemical Data. Part 1: Airshed and Watershed, 1982. p 260-311, 3 Fig, 30 Tab, 8 Ref.

Descriptors: *Watersheds, *Maryland, *Agricultural watersheds, *Forest watersheds, Phosphorus, Nitrogen, *Organic matter, *Elevation, *Soil surveys, Soil properties, Nitrates, Phosphates, *Nutrients, Hydrogen ion concentration, Ammonia, Nitrogen compounds, Soil chemistry.

Soil samples were taken from a forest, pastureland, and cornfield watershed of the Rhode River area during 1976-1978 and were analyzed for nutrient composition. Summary statistics are given for total P, total N and total organic matter and the data are summarized for each elevation contour of each of the three watersheds. No clear-cut elevation gradients are evident for total P, total N, or total organic matter, but all three showed distinct differences at some elevations. In all three watersheds, distinct gradients of declining nutrient content with soil depth were evident for all three parameters. The organic matter gradient was steepest in

the forest, slightly less in the pastureland, and least in the cornfield. The N gradient was steepest in the pastureland, slightly less in the forest and much less in the cornfield. The P gradient was steepest in the forest. The forest soils had the lowest pH, followed by pastureland and then cornfield soils. Soil pH decreased with depth in all three watersheds. The orthophosphate concentration (as a percentage of total-P) was least in forest soils and most in cornfield soils. Water-extractable orthophosphate was highest in the forest and least in the pasture. Total ammonia and total nitrate content of soils showed no clear-cut elevational gradients but declined with soil depth. Seasonal and annual variations in water-extractable orthophosphate, ammonia, nitrate and KCl-extractable ammonia are evident.
W85-05358

SEASONAL AND ANNUAL VARIATION IN RHODE RIVER WATERSHED HYDROLOGY,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
For primary bibliographic entry see Field 2B.
W85-05359

COMPARISON OF RAINFALL-RUNOFF MODELING TECHNIQUES ON SMALL UPLAND CATCHMENTS,
British Columbia Univ., Vancouver. Dept. of Geological Sciences.
K. M. Loague, and R. A. Freeze.
Water Resources Research, Vol. 21, No. 2, p 229-248, February, 1985. 8 Fig, 10 Tab, 54 Ref.

Descriptors: *Rainfall-runoff relationships, *Model studies, Mathematical models, Prediction, Catchment area, Permeability coefficient, Hydrographs, Forecasting.

The use of mathematical models to predict runoff from rainfall is investigated. Modeling efficiencies for three rainfall runoff models on three sets of data from small upland catchments are compared. The models are: a regression model, a unit hydrograph model, and a quasi-physically based model. The assessment of model performance in a forecasting mode requires the calculation of model efficiencies on a sequential event-by-event basis. The results of model efficiency calculations for three rainfall-runoff models on 269 events showed surprisingly poor efficiencies for all models on all catchments. The study does not point to any one modeling approach as being superior to all others for all catchments. The fact that simpler, less data intensive models in the form of regressions and unit hydrographs provided as good or better predictions than a more physically based model is food for thought. The poor performance of the quasi-physically based model is probably due to a combination of model error, input error, and parameter error. The performance of the quasiphysically based model was only slightly improved by calibration against its most sensitive parameter, the saturated hydraulic conductivity. The performance of the unit hydrograph model was probably handicapped by the small size of the catchments studied. (Baker-IVI)
W85-05502

DESIGN DISCHARGES ESTIMATION FOR VARIOUS DESERT SITES NEAR THE DEAD SEA (ISRAEL),
TAHAL-Water Planning for Israel Ltd., Tel-Aviv.
E. Simon, and Y. Last.
Journal of Hydrology, Vol. 76, No. 1/2, p 163-181, January, 1985. 6 Fig, 7 Tab, 12 Ref.

Descriptors: *Design discharge, *Estimating, *Deserts, *Israel, *Dead Sea, Hydrographs, Flood frequency, Arid lands, Watersheds, Bridges, Culverts.

A procedure for estimating design hydrographs in areas where no records exist, even for regional flood frequency analysis, is presented. Specifically the study was used to give estimates of design discharges for various recurrence intervals required for the design of bridges and culverts at several sites along the Ein Gedi-Ein Boqeq road. The scarcity of data at the region ruled out the direct application of regional flood frequency analysis and led to the alternative of using a watershed model to simulate design discharges of pattern watersheds. The similarity between the pattern watersheds and the watersheds of the above mentioned sites, later enabled the determination of the required design discharges and also the establishment of regional relationships between design discharges, watershed areas and recurrence intervals. The final results of the study were the presentation of two charts which demonstrated the regional relationships between design discharges, watershed areas and recurrence intervals for future design purposes. These charts differ from the regular regional flood frequency analysis plottings by introducing not only watershed areas, but also some other watershed characteristics, represented by the model parameters. (Baker-IVI)
W85-05539

PETROLEUM REFINERY STORMWATER RUN-OFF STUDY,
Standard Oil Co. (Ohio), Cleveland.
R. B. Stalzer, and G. W. McArdle.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 893-902, 14 Fig, 1 Tab, 4 Ref.

Descriptors: *Storm runoff, *Computer models, *Oil refineries, Industrial wastes, Oil industry, Oily water, Flow measurement, Design storms, Diversion, Reservoirs, Management planning, Wastewater treatment, Monitoring, Sewers.

A stormwater run-off study was conducted at a large petroleum refinery to: 1) estimate the peak flow rate and total impounding volume required for design storm events using stormwater run-off computer modeling; 2) install automatic flow recorders to obtain data that can be used for calibrating the computer model and improve simulation of stormwater run-off; 3) develop a conceptual design for an improved diversion and impounding system; and 4) prepare a stormwater management plan that summarizes all aspects of the study. Key elements of the stormwater management plan are outlined, including: identify all areas contributing stormwater run-off to the refinery's oily sewer system; establish the system and subbasin characteristics and hydraulics; determine the maximum flow rate allowable to the wastewater treatment system during a storm event; select the design storm events for estimating peak flow and total required impounding capacity needed for conceptual design purposes; use stormwater run-off computer modeling to develop design hydrographs; calibrate the model with data from a sewer monitoring program using automatic flow recorders; and develop a conceptual plan of an improved diversion and impounding system.
W85-05572

2B. Precipitation

SATELLITE PASSIVE MICROWAVE RAIN RATE MEASUREMENT OVER CROPLANDS DURING SPRING, SUMMER AND FALL,
Wisconsin Univ.-Madison. Space Science and Engineering Center.
R. W. Spencer.
Journal of Climate and Applied Meteorology, Vol. 23, No. 11, p 1553-1562, November, 1984. 8 Fig, 4 Tab, 18 Ref. NOAA/NESDIS contract NA-80-SAC-00742.

Descriptors: *Remote sensing, *Rainfall rate, *Microwaves, *Satellite technology, Precipitation intensity, Nimbus-7, Scanning multichannel microwave radiometer.

Rain rate algorithms for spring, summer and fall that have been developed from comparisons between the brightness temperatures measured by the Nimbus-7 Scanning Multichannel Microwave Radiometer (SMMR) and rain rates derived from operational WSR-57 radars over land are described. Data were utilized from a total of 25 SMMR passes and 234 radars, resulting in approximately 12,000 observations of approximately 1600 sq km areas. Multiple correlation coefficients of 0.63, 0.08 and 0.75 are achieved for the spring, summer and fall algorithms, respectively. Most of this information is in the form of multifrequency contrast in brightness temperature, which is interpreted as a measurement of the degree to which the land-emitted radiation is attenuated by the rain systems. The SMMR 37 GHz channel has more information on rain than any other channel. By combining the lower frequency channels with the 37 GHz observations, variations in land and precipitation thermometric temperatures can be removed, leaving rain attenuation as the major effect on brightness temperature. Polarization screening at 37 GHz is found to be sufficient to screen out cases of wet ground, which is only important when the ground is relatively vegetation free. Heavy rain cases are found to be a significant part of the algorithms' success, because of the strong microwave signatures (low brightness temperature) that result from the presence of precipitation-sized ice in the upper portions of heavily precipitating storms. If IR data are combined with the summer microwave data, an improved (0.85) correlation with radar rain rates is achieved. (Author's abstract)
W85-04984

SPACE TIME ANALYSIS OF HOURLY PRECIPITATION MEASURED IN THE SOUTH EAST OF FRANCE DURING THE ALPEX CAMPAIGN (ANALYSE SPATIO-TEMPORELLE DES PRECIPITATIONS HORAIRES MESUREES DANS LE SUD-EST DE LA FRANCE LORS DE LA CAMPAGNE ALPEX),
Centre d'Etudes de la Neige, Saint-Martin d'Heres (France).
J. P. Navarre, and E. Nicolet.
La Houille Blanche, Vol. 6/7, p 451-458, 1984. 9 Fig, 5 Ref.

Descriptors: *France, *Precipitation monitoring networks, *Rainfall distribution, *French Alps, *Massif Centrale, *Provence, *Jura, Forecasting, Weather forecasting, Hydrologic maps.

In the context of the Alpex programme, CEN has set up an index file of hourly precipitation measurements for the two month period March and April 1982. 124 recording rain gauges were selected from the EDF, SRAE and weather forecasting networks, from the French Alps to the South East of the Massif Centrale, and from Provence to the South of the Jura. This index file was used for a space time study of fine scale precipitation fields, based on meteorological and orographical conditions. The study was particularly concerned with quantifying organized distribution structures by developing and using automatic cartographic methods. (Author's abstract)
W85-05017

STUDIES ON DROUGHTS OF TAMIL NADU WITH SPECIAL REFERENCE TO THEIR SPREAD AND SEVERITY,
Cochin Univ. (India). Dept. of Marine Sciences.
H. S. Ram Mohan.
Mausam, Vol. 35, No. 3, p 253-256, July, 1984. 2 Fig, 2 Tab, 6 Ref.

Descriptors: *Droughts, *Tamil Nadu, *India, *Water budget, Rainfall distribution, Soil moisture.

Drought cannot be defined in terms of rainfall deficiency alone, without taking into account the water need of the region and the role of soil moisture. Droughts during the period 1901-1975 over Tamil Nadu, India, and vicinity were analyzed by the application of the water balance approach. Aridity anomaly diagrams on a yearly basis were drawn which show annual fluctuation in aridity presumably caused by large-scale changes in general circulation of the atmosphere. With the annual patterns as a basis, drought spread diagrams on a monthly basis were drawn to identify the 'core' areas and periods. After identifying the drought spells of various intensities and their spread, the cumulative effect of these water deficiencies in dry spells were assessed by employing the cumulative deviation technique. This method

besides giving an objective assessment of drought severity, also indicates the beginning, duration and end of a drought spell. The present investigation has brought forth the utility of the water balance procedure in drought analysis. The study of drought spread and intensification in particular is of great practical importance in agriculture and hydrological planning. (Collier-IVI)
W85-05073

PROBABILITY ANALYSIS OF RAINFALL AND EVOLVING CROPPING SYSTEM FOR COIMBATORE,
Tamil Nadu Agricultural Univ., Coimbatore (India).
R. Kulandaivelu.
Mausam, Vol. 35, No. 3, p 257-258, July, 1984. 1 Tab, 2 Ref.

Descriptors: *Rainfall distribution, *Cropping systems, *Coimbatore, *India, *Agriculture, Crop production, Model studies, Drought, Monsoons, Seasonal variation.

The daily precipitation data of Coimbatore center, India, for a period of 70 years were computed for weekly totals using a computer based incomplete gamma distribution model. The assured weekly rainfall amounts with a 50% probability level were taken as a measure of the adequacy of dependable precipitation and the probability of receiving a given amount of rainfall was worked out. The data indicate the likely commencement of rains, period of drought, length of growing season and end of growing season. In Coimbatore, the highest rainfall peak is noticed in October/November. For the rest of the period there is no high peak of rainfall. The prominent peak is observed in the 42nd week when the lowest assured rainfall amount is 30.8 mm at 50% probability level. The likely commencement of rains is the 40th week and the length of the growing season is the 40th to 49th week without any stress period. Continuous maximum assured rainfall at 50% probability level is received during the northeast monsoon period of October-December; it is the longest wet period during which a successful rainfed crop can be raised. Growing of improved sorghum varieties mixed with pulses is recommended to suit the rainfall pattern of Coimbatore center. (Collier-IVI)
W85-05074

EVALUATION OF AGRICULTURAL DROUGHT USING PROBABILITY DISTRIBUTION OF SOIL MOISTURE INDEX,
Indian Agricultural Research Inst., New Delhi. Div. of Agricultural Physics.
U. S. Victor, and P. S. N. Sastry.
Mausam, Vol. 35, No. 3, p 259-260, July, 1984. 1 Tab, 12 Ref.

Descriptors: *Drought, *Delhi, *India, *Cropping, *Seasonal variation, *Agriculture, Kharif crops, Soil moisture index, Evapotranspiration, Monsoons.

Weekly soil moisture budget was worked out for kharif cropping season July through October for 33 years (1940-1972) for Delhi, India, which has a semi-arid monsoonal climate. For this purpose the step function approach using climatological data suggested by Slatyer (1960) was followed. Soil moisture index (SMI), the ratio of available water to available water capacity in the soil root zone is directly related to the ratio of actual and potential evapotranspiration. Frequency distribution of weekly SMI values were evaluated and compared with the Beta distribution. Kolmogorov-Smirnov test of goodness of fit indicated the Beta distribution to be a suitable statistical model for approximating the frequency distribution of SMI for the monsoon season. For the threshold values corresponding to agricultural drought as well as potential moisture conditions in the root zone in respect of kharif crops, viz., sorghum, pearlmillet, corn, paddy and peanut crops grown in the Delhi region, the frequency of occurrence of agricultural drought during the monsoon season in the different phenological stages was determined. These results are discussed with reference to selection of a cropping pattern tailored to rainfall distribution of the region. (Author's abstract)
W85-05075

AGRICULTURAL DROUGHTS AND CROP PLANNING - A CASE STUDY FOR WESTERN RAJASTHAN,
Central Arid Zone Research Inst., Jodhpur (India).
A. S. R. A. S. Sastri, Y. S. Rama Krishna, G. G. S. N. Rao, and B. V. Ramana Rao.
Mausam, Vol. 35, No. 3, p 261-264, July, 1984. 2 Tab, 11 Ref.

Descriptors: *Drought, *Agriculture, *Cropping, *Rajasthan, *India, Millet, Kharif crops, Evapotranspiration, Rainfall.

The frequencies of occurrence of agricultural droughts with regard to pearlmillet and kharif pulses (the local major rainfed crops) were determined for stations in western Rajasthan, India; the stations represent semi-arid (Sikar), arid (Jodhpur) and extremely arid (Barmer) types of climates. Based on the minimum required values of the actual to potential evapotranspiration ratio for these crops, the intensities of drought during different cropping seasons (1956-1975) were determined. In western Rajasthan, kharif pulses are more susceptible to drought than pearlmillet. Even the pearlmillet crop is vulnerable to drought, with there being a 75% probability of drought during either the main growth or reproductive stages of crop growth when sown early during the 25th standard week. The crop is vulnerable to drought with 70% probability during reproductive stage when sown from the 29th to 31st week. (Collier-IVI)
W85-05076

DROUGHT YEAR OF 1979 - A CRITICAL APPRAISAL WITH REFERENCE TO THE SEMI-ARID REGION OF DELHI,
Indian Agricultural Research Inst., New Delhi. Div. of Agricultural Physics.
C. V. S. Sastri.
Mausam, Vol. 35, No. 3, p 273-276, July, 1984. 1 Fig, 2 Tab, 7 Ref.

Descriptors: *Drought, *India, *Delhi, *Agriculture, Seasonal variation, Rainfall, Hydrologic budget.

In the decade 1971-1980, India experienced three severe droughts which affected a major portion of the sub-continent. The failure of the southwest monsoon over India during 1979 resulted in widespread severe drought conditions in most parts of the country; agricultural production in the dryland tracts, especially, decreased considerably during the year. The frequency and severities of droughts that have occurred in the semi-arid region of Delhi were studied through the water balance procedure with emphasis on the year 1979. Monthly water balances for the period 1941-1980 at Delhi were worked out employing a water budgeting procedure. During the Kharif and Rabi seasons, the run off water balance components were studied on a weekly basis so as to determine the impact both individually and collectively on general crop growth in the region. The water balance parameters during 1979 were compared with those of normal, wettest and driest years in the decade as determined from water budgeting procedure and also from cumulative water deficit diagrams. The drought of 1979 was severe during the kharif season and affected the crop production adversely. The mild and moderate droughts of rabi season also had an equally bad effect because of their longer duration. A total of 35 out of 45 weeks were affected by droughts of all intensities. (Collier-IVI)
W85-05077

QUANTIFICATION OF DROUGHT AND CROP POTENTIAL,
Meteorological Office, Poona (India). Agricultural Meteorology Div.
B. C. Biswas, and P. S. Nayar.
Mausam, Vol. 35, No. 3, p 281-286, July, 1984. 3 Fig, 1 Tab, 13 Ref.

Descriptors: *Drought, *Climatology, *India, *Agriculture, *Moisture availability index, Climatic zones, Rainfall distribution, Cropping.

An agroclimatic classification based on a moisture availability index (MAI) was developed for demarcating agroclimatic zones of various crop potentials in the dry farming tract in India. That area, where annual rainfall varies from 40 to 100 cm, comprises 105 districts in nine states. In this tract rainfall is the limiting factor for successful raising of crops. In order to stabilize the crop at a certain level even in a low rainfall year, it is essential to know the frequency of drought years so that agricultural planning is drawn up on a rational scientific basis. For the purpose, amongst other things, it is necessary to know the minimum week by week rainfall at different probability levels. The lowest amount of rainfall at different probability levels (10 to 90%) was computed by fitting an incomplete gamma distribution probability model to weekly rainfall totals of 87 stations in the dry farming tract during the Indian monsoon season. The MAI, which is defined as ratio of probabilistic rainfall of a week to potential evapotranspiration, was computed. MAI at a 50% level has been used to map out drought prone areas. The period when MAI $>$ or $=$ 0.3 has been taken as the crop growing period. The mid-season water stress period, i.e., when MAI $<$ or $=$ 0.3 has been found out from 50% probability level and this period has been used to map out drought prone area both in time and space. Severity of drought has been classified by the number of water stress periods as well as their durations. A drought prone area extends from Aurangabad in Maharashtra to Bangalore in Karnataka. Occurrence of drought is frequent in Gujarat and eastern Rajasthan. (Collier-IVI)
W85-05078

STUDY OF ARIDITY AND DROUGHTS IN THE CLIMATIC SPECTRUM OF THE SOUTH INDIAN REGION,
Andhra Univ., Waltair (India). Dept. of Meteorology and Oceanography.
A. A. L. N. Sarma, and M. Ravindranath.
Mausam, Vol. 35, No. 3, p 287-290, July, 1984. 4 Fig, 2 Ref.

Descriptors: *India, *Drought, *Climatic zones, *Climatology, Rainfall distribution, Seasonal variation, Hydrologic cycle.

The nature of drought depends upon the amount and distribution of rainfall and its matching with the water need. These two aspects were studied in each climatic area of south India employing a water balance procedure. Since the main meteorological source of water supply to the Indian region is the southwest monsoon during the summer season, the moisture regime of the region has a strong seasonal aspect. Proneness of the different climatic types of the south Indian region to droughts was investigated by selecting one station from each zone of the climatic spectrum and plotting the yearly indices of aridity against years of record and categorizing the drought years. Decennial frequency of drought years is then calculated at each station and graphically plotted to get an insight into drought occurrence in the various climatic zones of the south Indian region. Fluctuations in the aridity index from year to year are rather mild at perhumid and arid climates since these climates are at the moist and dry extremes of the hydrologic cycle. (Collier-IVI)
W85-05079

AGROCLIMATIC APPROACH TO THE ASSESSMENT OF TROPICAL DROUGHTS,
Cochin Univ. (India). Dept. of Marine Sciences.
H. S. Ram Mohan, M. J. Stanislaus, and P. Valsala.
Mausam, Vol. 35, No. 3, p 291-294, July, 1984. 2 Fig, 1 Tab, 10 Ref.

Descriptors: *India, *Climatology, *Droughts, *Tropical zone, Water stress, Agriculture, Crop growth, Seasonal variation.

The yearly water balances of two representative stations in Peninsular India - Madurai, which has a

semiarid climate, and Cuddalore, which has a dry sub-humid climate - were worked out for a 75 year period (1901-1975) using a book-keeping procedure. The index of moisture adequacy (Ima) derived from water balance procedures was employed to categorize droughts from the agricultural and ecological point of view. Selected drought spells were analyzed critically by plotting the ratio of the departures of monthly Ima from the climatic normal, to the standard deviation of Ima for that month. This technique was found to be of great value in agricultural and ecological investigations as due weightage is given to the drought resistance and tolerance of crops which are adapted to the region. The same amount of water deficiency during the various seasons of the year and at different stages of crop growth cause varying moisture stress. This is a special interest in tropical regions where it is the moisture factor that inhibits the growth of vegetation to its potential levels. (Collier-IVI)
W85-05080

RAINFALL DISTRIBUTION OVER INDIA DURING THE MONSOON MONTHS IN THE ABSENCE OF DEPRESSIONS AND CYCLONIC STORMS,
Indian Inst. of Tropical Meteorology, Poona.
O. N. Dhar, B. N. Mandal, and P. R. Rakhecha.
Mausam, Vol. 35, No. 3, p 309-314, July, 1984. 1 Fig, 2 Tab, 11 Ref.

Descriptors: *India, *Rainfall distribution, *Monsoons, Seasonal variation, Droughts, Climatology.

It is well known that monsoon depressions and cyclonic storms play an important role in the distribution of rainfall over India. Naturally, their absence from the Indian area during any month of the monsoon season is considered to be responsible for causing deficient rainfall and consequent drought conditions. It is, therefore, of interest to know as to what extent the absence of these synoptic systems cause deficient rainfall during the individual monsoon months. This aspect has been examined by computing the average rainfall of the different meteorological sub-divisions of the Indian plains north of Lat. 15 degrees N for those monsoon months which were free from depression and clyclonic storms. There have been in all 25, 13, 7 and 4 occasions of June, July, August and September respectively, when no depressions or cyclonic storms moved through the Indian land area during the period 1891-1980. Of the 4 monsoon months, the September month is worst affected by the absence of these disturbances and in the case of other monsoon months of June, July and August, rainfall can be abnormally deficient depending upon the presence of any of the following meteorological situations: (a) Late arrival and subsequent weak monsoon conditions over the country, (b) The axis of monsoon trough remains shifted to the north of its normal position, and (c) Non-occurrence of low pressure areas (or land lows) across the country. Rainfall over the country can be normal or even above normal in spite of the absence of these disturbances if the meteorological situations like the above are not there. The absence of monsoon depressions and cyclonic storms are not the main factors which cause deficient rainfall and consequent drought conditions in this country. (Author's abstract)
W85-05081

DROUGHTS OVER PENINSULAR INDIA DURING 1861-1980 AND ASSOCIATED CIRCULATION FEATURES,
Indian Inst. of Tropical Meteorology, Poona.
D. A. Mooley, B. Parthasarathy, and N. A. Sontakke.
Mausam, Vol. 35, No. 3, p 337-342, July, 1984. 2 Fig, 6 Tab, 9 Ref.

Descriptors: *Droughts, *India, *Rainfall distribution, Monsoons, Climatology, Seasonal variation.

Droughts which affected the Peninsular India during the period 1861-1980 have been studied with well distributed rainfall data of 31 raingauge stations. The criterion used for identification of drought is the specific threshold value of rainfall expressed as standard unit, t sub i. If, in any year the t sub i value is less than -1.28, than the station is considered to be affected by drought. A year with 25 per cent of the stations considered suffered from drought is taken as large scale drought year over Peninsular India. There are 10 large-scale drought years during the period, 1876, 1877, 1891, 1899, 1905, 1913, 1918, 1920, 1952 and 1972. Statistical test shows that the time interval between two successive drought years is randomly distributed in time continuum. The worst drought occurred in the years 1899 and 1918 when more than 50% of the stations showed drought conditions. The circulation features, like position of monsoon trough and the depressions and storms, were examined with a view to understand the anomalies in rainfall during the large-scale drought years and the results presented. (Author's abstract)
W85-05082

DROUGHT PREDICTION IN INDIA FROM RADIATION PARAMETERS,
Meteorological Office, Poona (India).
A. Chowdhury, and G. S. Sarwade.
Mausam, Vol. 35, No. 3, p 345-348, July, 1984. 4 Fig, 3 Ref.

Descriptors: *Drought, *India, *Global radiation, *Diffuse radiation, *Solar radiation, Prediction, Radiation, Climatology, Rainfall distribution, Monsoons, Forecasting.

Monthly values of total global (G) and diffuse (D) radiation from January to May, for all available stations for a period 1961-79 have been utilized to predict drought in India. Drought was defined as a situation when over 20% of the area of the country had rainfall deficiency more than 25% of the seasonal (monsoon) normal. Departures from the normal value of total global radiation have been plotted, monthly as well as for the two seasons, viz, winter and pre-monsoon and analyzed to determine if its spatial distribution pattern bears any relationship with the drought occurrence in the succeeding monsoon season. Cumulative totals of G and its cumulative departures for individual stations were also plotted and examined in relation to drought. If during January the departures of the global radiation for the majority of stations among Jodhpur, Ahmedabad, Nagpur, Bangalore, Boa and Bombay are negative and those for Goa, Bangalore, Madras and Visakhapatnam are also negative in February, the year may witness drought conditions. These results have been tested for all stations for which data was available for 1979, the year in which the monsoon failed over large parts of India. At Goa and Ahmedabad, large negative departures prevailed during January. These were also negative for February for Goa and Viakhapatnam. The departures of global radiation during January and February may provide some prior indication of the monsoon activity during succeeding June to September months. (Collier-IVI)
W85-05083

PREDICTION OF DROUGHTS IN THE INDIAN ARID REGION,
Central Arid Zone Research Inst., Jodhpur (India).
Y. S. Rama Krishna, A. S. R. A. S. Sastri, G. G. S. N. Rao, and B. V. Ramana Rao.
Mausam, Vol. 35, No. 3, p 349-354, July, 1984. 4 Fig, 1 Tab, 10 Ref.

Descriptors: *Drought, *Prediction, *India, Arid zones, Seasonal variation, Climatology.

Drought is a recurring feature in the arid regions and prediction of droughts has great relevance to planning for afforestation, sand dune stabilization, establishment of grasslands etc. Some attempts have been made at the Central Arid Zone Research Institute, Jodhpur to develop techniques for prognostication of droughts in the Indian arid region on the basis of climatic fluctuations and variability. The climatic spectrum of the Indian arid region extends from extremely arid to semi-arid conditions. Through application of the theory of conditional probabilities based on first order Markov chain model, the climatic fluctuations during the years 1901-1970 were studied. It was observed that the occurrence of extreme arid conditions in the succeeding year could be predicted with 92 per cent confidence while climatic types can be predicted with 83 per cent confidence. Drought incidence may not be affecting the whole of the region simultaneously and some parts might experience localized droughts. However, in some years the whole region experienced drought conditions and studies reveal that even in such years the drought intensity and its time of occurrence varied from region to region. Studies on the incidence and spread of droughts over western Rajasthan indicate that drought conditions originate first in the northeastern region, during the month of July spread in a southwesterly direction during the month of August and dissipate with an easterly movement in the month of September. This pattern is observed to repeat during the years of severe drought. The applicability of the above techniques were discussed. Long range prediction of droughts is not yet possible with 100 per cent confidence. Therefore, a combination approach using different techniques might provide the necessary confidence in prediction of droughts. (Author's abstract)
W85-05084

ANALYSIS AND PREDICTION OF SHORT PERIOD DROUGHTS DURING SUMMER MONSOON OVER INDIA,
Indian Inst. of Tropical Meteorology, Poona.
S. V. Singh, R. H. Kripalani, P. Saha, and K. D. Prasad.
Mausam, Vol. 35, No. 3, p 361-366, July, 1984. 5 Fig, 3 Tab, 7 Ref.

Descriptors: *Droughts, *Monsoons, *India, *Prediction, Climatology, Spatial distribution, Rainfall distribution.

Climatic characteristics of occurrence of dry spells over 7 meteorological subdivisions lying in semi-arid parts of India were studied using 23 years of spatially averaged subdivisional rainfall data. Five different thresholds were used to decide the occurrence of dry or wet day over the subdivisions. Similar characteristics in occurrence of dry spells were studied for 6 stations lying in the same area. The Markov chains of order 1 and 2 were fitted to the frequency of occurrence of dry spells over the stations and on testing, the chain of order 2 are found to fit better. Composite charts of probability of occurrence of rain around depressions located in various geographical areas were prepared by using daily rainfall data of 220 stations for 19 years. With the help of these charts the role of depressions in alleviating drought situation was examined. Multiple linear regression equations were developed by a stepwise screening method to predict the daily rainfall amounts over these subdivisions by using large scale synoptic parameters. When tested on an independent sample of equal size these equations showed skill scores varying from 0.22 to 0.54 in forecasting the terciles of rainfall. (Author's abstract)
W85-05085

SOME CLIMATOLOGICAL ASPECTS OF DROUGHT IN INDIA,
Meteorological Office, Poona (India).
A. Chowdhury, and V. P. Abhyankar.
Mausam, Vol. 35, No. 3, p 375-378, July, 1984. 2 Fig, 3 Tab, 3 Ref.

Descriptors: *Drought, *India, *Climatology, *Rainfall distribution, Spatial distribution, Arid zone, Climatic zones.

The drought climatology of India was compiled and collected based on data from 1875 to 1980. Only 'meteorological drought', i.e., rainfall deficiency exceeding 25% of the normal was considered. Frequency of occurrence of drought in different meteorological sub-divisions was obtained which has been used to determine its recurrence period. Drought was classified into moderate and severe categories and the probability of occurrence of these types in different sub-divisions was computed. Depending upon the area of the country affected, drought was further classified into different categories, viz., localized, semi-vast, vast extensive and calamitous, observed frequency of each

type determined. Decadal representation of the drought incidence was obtained and used to predict its occurrence in any 10-year period. The series was also subjected to power spectrum analysis and significant peaks were obtained. Since no rational criteria to define a year as a good or bad monsoon year for the country as a whole exists at present, an objective and pragmatic approach to solve this problem was attempted. The following two categories were separately adopted to consider a year as a drought year, viz., (i) When the percentage area affected exceeds 20%, (ii) When the area exceeds 25%. Sequences of a drought year or a good monsoon year were obtained. This has subsequently been examined to obtain probabilities of a drought year following (a) 3 consecutive good years, (b) 4 good years, and (c) 5 good years. Similarly, chances of two consecutive years of drought after each of 3, 4 and 5 consective good monsoon years were determined. These sequences were utilized to find persistence in occurrence of good or bad (drought) monsoon years and subjected to the chi square test to determine its statistical significance. (Author's abstract)
W85-05086

ANALYSIS OF TRENDS IN THE RAINFALL AND DROUGHTS OCCURRING IN THE SOUTHWEST MONSOON AND NORTHEAST MONSOON SYSTEMS IN THE SOUTHERN PENINSULAR INDIA,
University of Agricultural Sciences, Bangalore (India).
A. Krishnan.
Mausam, Vol. 35, No. 3, p 379-386, July, 1984. 6 Fig, 2 Tab, 12 Ref.

Descriptors: *Rainfall distribution, *Droughts, *Karnataka, *Tamil Nadu, *India, *Monsoons, Climatology, Spatial distribution, Seasonal variation.

Previous climatic classification studies of India were based only on the data of meteorlogical observatories for which long period normals were available. A detailed climatic classification of Karnataka and Tamil Nadu States of southern Peninsular India which receive rainfall from both southwest and northeast monsoon has been made by using the data of all provincial raingauge stations in these States for the period 1901-75; a comparison of the same is made with earlier classifications. A comparision of the rainfall normals (1901-1950) with the rainfall amounts recorded at different stations in these States during 1951-1975 indicates that decreases in annual rainfall have occurred in the latter period for many regions in Tamil Nadu which receive rainfall predominently during northeast monsoon, whereas increases have occurred in Malnad area, coastal Karnataka and north Interior Karnataka which receive rainfall mostly during southwest monsoon. The method of time series analysis of rainfall by stochastic processes was described. Use of this approach would shed light on the trends, if any, that occur and would help in a seasonal forecasting of monsoon rainfall. (Collier-IVI)
W85-05087

STOCHASTIC MODEL OF DROUGHT,
Indian Inst. of Tropical Meteorology, Poona.
P. P. Kamte, and S. D. Dahale.
Mausam, Vol. 35, No. 3, p 387-390, July, 1984. 4 Fig, 1 Tab, 6 Ref.

Descriptors: *India, *Drought, *Model studies, Climatology, Rainfall distribution, Seasonal variation.

A stochastic process was applied to daily rainfall series of various meteorological sub-divisions and of different climatic regimes in India. An autoregressive AR(1) model was used to generate m-day minimum rainfall with the auto-correlations estimated through a statistically transformed distribution of minimum rainfall of different durations. The model satisfactorily explains the observed minimum rainfall of different durations; the probabilities of minimum rainfall of different durations are estimated to understand how best one can delineate the areas of droughts. During the month of June, Gujarat, Saurashtra, Kutch, Rajasthan (east and west), Tamilnadu and Rayalaseema show more than 50% of days with no measurable precipitation (2.5 mm is taken as measureable precipitation). During the month of September, except for the regions of Gujarat, Saurashtra, Kutch and Rajasthan (east and west), the rest of the divisions show less than 50% of the days with no measurable precipitation. (Collier-IVI)
W85-05088

STATISTICAL STUDY ON INCIDENCE OF DROUGHT IN RELATION TO AGRICULTURAL PRODUCTION,
Indian Agricultural Statistics Research Inst., New Delhi.
P. Narain, P. N. Bhargava, and A. Saksena.
Mausam, Vol. 35, No. 3, p 391-396, July, 1984. 2 Fig, 6 Tab, 6 Ref.

Descriptors: *India, *Drought, *Statistical analysis, *Agriculture, *Crop production, Rainfall distribution, Climatology, Arid zone, Jowar.

In India about 75 per cent of the cultivated area is rainfed and since about 42 per cent of India's food comes from such areas, there is considerable variation in food production depending upon the amount and distribution of rainfall. The annual rainfall in India's semi-arid areas is usually less than 75 cm and there sometimes occur prolonged dry spells within the rainy season. An agricultural drought is caused by a rainfall deficiency spread over a long duration during the crop season. The intensity of drought is related to the duration of the period during which total rainfall is deficient in relation to that required by the crop for its growth. Conditions for drought for a specific period in relation to a given variety of crop in the region may be determined with the help of rainfall distribution and potential evapotranspiration values. The agricultural drought and its intensity were characterized using data on rainfall and yield of a crop like jowar for certain semi-arid areas of western India. The estimates of the minimum amount of rainfall which is just sufficient for crop growth during a given number of consective weeks were worked out. The occurrence of rainfall below these drought base values gives rise to drought conditions. These values were used to determine the probability estimates of the occurrence of drought of varying durations. In Jamnagar and Surendra Nagar, the occurrence of drought of 9 week duration during early August and end of September is relatively more frequent and is expected to occur once in four and five years respectively. (Collier-IVI)
W85-05089

EXTREME PROBABILITY ANALYSIS OF DROUGHT PERIODS IN MONSOON IN RELATION TO WATER NEED OF CROP STAGES,
Marathwada Agricultural Univ., Parbhani (India). Dept. of Bio-Meteorology.
G. Ramakrishna Rao, and D. G. Phulari.
Mausam, Vol. 35, No. 3, p 397-402, July, 1984. 5 Fig, 5 Tab, 6 Ref.

Descriptors: *Drought, *India, *Crop production, *Agriculture, *Monsoons, Seasonal variation, Rainfall distribution.

Extreme probability analysis of drought periods were conducted on daily rainfall from 1944 to 1976 for frequencies 7, 10, 15, 20 and 25 days to adjust crop phases according to their water need. The study indicated that the first fortnight of June, second fortnight of July, first fortnight of August and second fortnight of September are not suitable for sowing, flowering and pod formation, panicle initiation, earhead emergence and grain filling of kharif crops respectively. If the crop phases are adjusted as per their water need with the available depth of rainfall three years of very successful cropping may be expected, as would five years with success with the crops possibly undergoing severe mositure stress in a two year period. If the proper crop sequence is chosen the crops would have a good harvest in a year particularly where the soil depth exceeds a meter. (Author's abstract)
W85-05090

MARKOV CHAIN MODEL FOR THE PROBABILITY OF DROUGHT INCIDENCE IN INDIA,
Meteorological Office, Poona (India).
A. Chowdhury, and V. P. Abhyankar.
Mausam, Vol. 35, No. 3, p 403-405, July, 1984. 2 Tab, 6 Ref.

Descriptors: *Markov Chain modeling, *Model studies, *Drought, *India, *Climatology, Rainfall distribution, Seasonal variation.

For each sub-division, each year has been classified as a drought year when the seasonal rainfall is less than 75% of the normal and as a non-drought year when the seasonal rainfall is greater than 75% of the normal. This mode of classification yields a sequence of drought and non-drought years which can be regarded as a two-state Markov chain. Seasonal rainfall departures for the period 1875-1974 have been subjected to Markov Chain analysis to determine the conditional probabilities of drought/non-drought years. One meteorological sub-division from each of the climatic type was selected; viz., per-humid, humid, sub-humid (dry and moist), semi-arid and arid regions. Expected length of climatic cycles, that is drought spell followed by a non-drought spell and vice versa, were computed. Considerable variations were observed in the expected lengths of non-drought spells which varies from 23.8 years for Orissa to 5.0 at Telangana. A noteworthy feature is that the expected lengths are greater than the observed lengths at all regions except Telangana where they are equal. Observed lengths of climatic cycles fluctuated from 20.4 years at Orissa to 4.6 years at west Rajasthan, whereas the expected lengths for these two regions were respectively 24.8 years and 4.9 years. Since the non-drought cycles do not confirm to the geometrical model, as such the length of the climatic cycle does not have much significance. (Collier-IVI)
W85-05091

APPLICATION OF MARKOV CHAIN MODEL IN DETERMINING DROUGHT PRONENESS,
Meteorological Office, Poona (India). Agricultural Meteorology Div.
N. N. Khambete, and B. C. Biswas.
Mausam, Vol. 35, No. 3, p 407-410, July, 1984. 3 Fig, 1 Tab, 5 Ref.

Descriptors: *Maharashtra, *India, *Drought, *Markov Chain model, *Model studies, Rainfall distribution, Crop production, Agriculture, Climatology.

A first order two state Markov chain model was used to evaluate sequences of dry and wet weeks during a southwest monsoon period over the dry farming tract of Maharashtra, India and an index based on parameters of this model was developed to bring out the degree of drought proneness. A threshold value of 18 mm potential evapotranspiration for the 23-41 week period was chosen for the study area. The dry farming tract of Maharashtra was delineated into five zones of different degrees of drought proneness. In chronic drought-prone areas crop failure is very frequent. In severe drought-prone areas a good crop may be raised in about 35% of the years. In moderately and mild drought prone areas a good crop may be raised in about 40-50% and 50-55% of the years and crop prospect is high in occasional drought prone areas. Better results will emerge if atmospheric demand and soil characteristics of the region are superimposed on these results. (Collier-IVI)
W85-05092

RAINFALL FLUCTUATIONS IN INDIA AND SRI LANKA AND LARGE-SCALE RAINFALL ANOMALIES,
Hanover Univ. (Germany, F.R.). Inst. fuer Meteorologie und Klimatologie.
H. Fleer, B. Schweitzer, and W. Raatz.
Mausam, Vol. 35, No. 2, p 135-144, April, 1984. 9 Fig, 26 Ref.

Descriptors: *Rainfall distribution, *India, *Sri Lanka, *Climatology, El Nino, Monsoons, Walker Circulation, Spatial distribution.

During 1972, world-wide climatic anomalies considerably affected the production of food in tropical countries. Statistical methods were used to investigate the homogeneity, temporal trends, and spatial and temporal distribution of fluctuations in rainfall series for stations in India and Sri Lanka. During 1972 India suffered from a widespread failure of the monsoon rains, upon which the country is so dependent. At some stations in the southwestern part of the subcontinent rainfall was only 50% of normal. During the same year, extraordinary rainfall was registered in the equatorial Pacific. Teleconnections between Indian rainfall and rainfall in the equatorial Pacific dry zone were analyzed. The rainfall series for Indian stations are characterized by pronounced spatial and temporal variations. The temporal fluctuations were investigated using running means, variabilities/auto-correlation and variance spectrum. Significant long-period fluctuations are evident at certain Indian stations but appear not to be a uniform trend in India over the last 100 years. There appears to be a linkage between the recurrent Indian droughts and the El Nino phenomena along the west coast of South America. In all years with rainfall deficits in India, high sea-surface-temperatures and excess rainfall occur in the equatorial Pacific. In El Nino years the Walker-Circulation is either reduced or disrupted by the weak atmospheric pressure gradient between the subtropical Pacific high and the Malayan-Indonesian low and by the decreasing equatorial zonal sea-surface-temperature gradient. A high (low) index that corresponds to a strongly developed (reduced) Walker-Circulation and to an intensified (weakened) upwelling along the equator and off the west coast of South America is connected with high (low) Indian and low (high) Pacific precipitation. (Collier-IVI)
W85-05093

RAINFALL OVER LAKES AROUND BOMBAY,
Meteorological Office, Poona (India).
A. K. Mukherjee, B. Shyamala, and S. G. Apte.
Mausam, Vol. 35, No. 2, p 165-170, April, 1984. 8 Fig, 6 Tab.

Descriptors: *Rainfall distribution, *Bombay, *India, *Seasonal variation, Rainfall intensity, Temporal distribution.

Bombay city and suburbs get their water supplu chiefly from the lakes Tulsi, Tansa, Powai, Vehar and Vaitarna. Mean monthly rainfall for four of the lakes for the period 1901-50 (Vaitarna was not commissioned until 1956) along with the seasonal totals have been calculated for the chief rainy months of June thru September which corresponds to the southwest monsoon period. Many conclusions based on statistical studies have been arrived at by analyzing monthly, seasonal, pentad and daily rainfall normals. Average seasonal rainfall is maximum at Tulsi. Year to year variation of seasonal and monthly rainfall is generally similar for all lakes and Colaba. Average monthly rainfall is less variable in July as compared to other months. During June rainfall is less variable in Colaba, Behar, Powai, but during August and September it is less variable in lakes Tansa and Vaitarna. Coefficient of variation for the seasonal rainfall is low, of the order of 22% for the lakes and Colaba. From analysis of actual daily rainfall data for 50 years, it is seen that the number of occasions with heavy/very heavy rainfall are only about 2%. (Collier-IVI)
W85-05094

TEMPORAL FLUCTUATIONS OF SEASONAL RAINFALL PATTERNS IN EAST AFRICA,
Nairobi Univ. (Kenya). Dept. of Meteorology.
L. Ogallo.
Mausam, Vol. 35, No. 2, p 175-180, April, 1984. 7 Fig, 1 Tab, 22 Ref.

Descriptors: *Rainfall distribution, *Seasonal variation, *Temporal distribution, *Kenya, *Tanzania, *Uganda, Statistical analysis, Mathematical studies, Precipitation.

In order to investigate temporal fluctuations in the seasonal rainfall over East Africa, monthly rainfall records from about 100 stations during the period 1931-75 were subjected to harmonic analysis on the yearly basis. Under this method time series were generated from the yearly amplitude and phase angle values of the dominant harmonics for the period 1931-75. The temporal fluctuations of the generated time were used to describe temporal patterns of seasonal rainfall in East Africa during the period of study. Yearly fluctuations in the pentad rainfall were also investigated during the wet seasons. The results from harmonic analysis indicated the dominance of the first three harmonics over most region of East Africa. Higher harmonics, however, explained substanial variance in some dry regions. The statistical methods employed indicated that at 95% confidence level, no significant seasonal changes or shifts could be detected in the seasonal rainfall patterns. Spectral analysis, however, displayed short period fluctuations within the ranges of 2-3 years and 5-6 years. A weak 10-11 years peak also appeared in some series. (Author's abstract)
W85-05096

STUDY OF MAJOR RAINSTORMS OF THE TEESTA BASIN,
Flood Meteorological Office, Jalpaiguri (India).
B. Biswas, and C. V. V. Bhadram.
Mausam, Vol. 35, No. 2, p 187-190, April, 1984. 6 Fig, 3 Tab, 4 Ref.

Descriptors: *India, *Teesta River basin, *Rainstorms, Rainfall distribution, Rainfall intensity, Temporal distritution.

Rainfall distribution based on data from 1960-1981 was studied for the river Teesta catchment extending from its origin in north Sikkim (India) up to the Indo-Bangladesh border. The average monthly and annual rainfall of the Teesta basin were worked out by the isohyetal method. 53 rainstorms occurred during the period of durations of 1 to 3 days were analysed. Out of those storms, 40 are of one-day, 11 are of two-day while only 2 are of three-day duration. One possible cause for the high frequency of one-day storms is the narrow width of the catchment for which the effect of any moving synoptic system lasts for a shorter duration. Rainstorms are most frequent during the month of July. For the period under study, the rainstorm of 3-5 Oct 1968 has made maximum contribution of average depth of rainfall for 1, 2 and 3-day durations. This heavy rainstorm occured in association with a cyclonic storm which originated in the Bay of Bengal and ultimately broke up over the Himalayan region of north Bihar as a low pressure area. (Collier-IVI)
W85-05097

ELECTRONIC DISCRIMINATOR TO ELIMINATE THE PROBLEM OF HORIZONTAL RAINDROP DRIFT,
Missouri Univ.-Columbia. Dept. of Agronomy.
For primary bibliographic entry see Field 7B.
W85-05193

CONTINUING DESIGN, REVIEW, AND ANALYSIS WORK FOR THE SIERRA COOPERATIVE PILOT PROJECT,
North American Weather Consultants, Salt Lake City, UT.
For primary bibliographic entry see Field 3B.
W85-05349

SEASONAL AND YEARLY VARIATION IN METEOROLOGICAL PARAMETERS AT THE CHESAPEAKE BAY CENTER FOR ENVIRONMENTAL STUDIES,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
For primary bibliographic entry see Field 2A.
W85-05354

SEASONAL AND ANNUAL VARIATION IN RHODE RIVER WATERSHED HYDROLOGY,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
D. L. Correll.
In: Environmental Data Summary for the Rhode River Ecosystem (1970-1978), Section A: Long Term Physical/Chemical Data, Part 1: Airshed and Watershed, 1982. p 312-343, 3 Fig, 14 Tab, 7 Ref.

Descriptors: *Watersheds, *Maryland, *Precipitation, *Runoff, *Discherge measurement, *Rainfall runoff relationship, *Annual distribution, *Seasonal variation, *Data collections, Statistical analysis, Hydrologic data, Rhode River Watershed, Hydrology.

Seasonal and annual variance in precipitation and runoff was studied in each of 11 basins of the Rhode River watershed. Water discharge was measured with sharp-crested Vee-notch weirs located along stream beds of subbasins and precipitation data was obtained from the CBCES weather station. Long-term (160 yr) mean average annual precipitation is 108 cm. The long-term average precipitation for spring, summer, fall in winter was 28.0 cm, 31.4 cm, 24.5 cm and 24.6 cm, respectively. Discharge data for the watersheds showed mean annual discharges ranging from 9.99 to 49.51 cm. Although precipitation was rather even from season to season, discharge is normally greater in the spring and winter, less in the fall, and least in the summer. Weekly precipitation and discharge data showed periods of increasing or declining discharge rates and periods of drought interrupted by a short period of heavy rain. The periods of increasing and declining discharge were also found to give different patterns if they were within the season of high evapotranspiration. Runoff data show different proportions of runoff between basins for the same storm events.
W85-05359

WATER AVAILABLE FOR RUNOFF FOR 1 TO 15 DAYS DURATION AND RETURN PERIODS OF 2 TO 100 YEARS FOR SELECTED AGRICULTURAL REGIONS IN THE NORTHWEST UNITED STATES,
National Weather Service, Silver Spring, MD.
F. Richards, J. F. Miller, E. A. Zurndorfer, and N. S. Foat.
NOAA Technical Report NWS 36. April 1983. 59 p, 33 Fig, 9 Tab, 16 Ref, 5 Append.

Descriptors: *River forecasting, *Snowmelt, *Runoff, Annual runoff, Cumulative runoff, Storm runoff, Precipitation, Cultivated lands.

Through adaptation of the National Weather Service River Forecast System (NWSRFS) snow accumulation and ablation model, this study estimates the frequency of water available for runoff (WAR) from snowmelt and precipitation over selected agricultural areas in the northwest United States. The report outlines the adaptation, testing, and use of the NWSRFS model and presents maps of 1-, 5-, and 15-day, WAR values for 2- and 100-year return periods. Comparison of WAR-frequency estimates with previous precipitation-frequency values shows regions of substantial difference. As a byproduct of the analysis, model-derived water equivalent frequency estimates are also presented.
W85-05363

FIFTEEN YEARS OF AFRICAN DROUGHT,
R. A. Kerr.
Science, Vol. 227, No. 4693, p 1453-1454, March, 1985. 2 Fig, 2 Ref.

Descriptors: *Drought, *Sub-Sahara, *Africa, Lake Chad, Rainfall, Evaporation, History.

The catastrophe of the sub-Saharan drought began toward the end of the 1950s when nearly a decade of unusually wet weather ended and precipitation amounts more typical of the first half of the century returned. But the drop in rainfall continued and a 5 year pulse of dryness peaking in 1972 brought world wide attention to the area. Another, sharper pulse of drought peaked in 1977, equaling the intensity of the 1972 pulse. In 1979, after once again approaching but failing to reach normal, annual precipitation began falling year by year. Records of an earlier drought like this one have been found, making it thus unlikely that the drought was man-made. One measure of sub-Saha-

ran drought intensity is the withdrawal of the edge of Lake Chad as more water evaporates from it than drains into it. The lake was as small in the 1820-1840 drought as it was in 1979. The most pressing question is when will the present crisis ease, but meteorologists can only guess. The 1972 pulse intensified for 2 years before it peaked and took 2 years to approach normal again. The current peak of dryness, if it is a peak, was more than 4 years in the making. An equally long return to normal would not be surprising. (Baker-IVI)
W85-05462

NOTE ON SELECTING AN OPTIMUM RAINGAUGE SUBSET,
Waikato Univ., Hamilton (New Zealand). Dept. of Earth Sciences.
W. E. Bardsley, and B. F. J. Manly.
Journal of Hydrology, Vol. 76, No. 1/2, p 197-201, January, 1985. 1 Fig, 3 Ref.

Descriptors: *Rain gages, *Regression analysis, Catchments, Mathematical studies, Optimization, Rainfall, Measuring instruments, Network design.

All subsets regression is a useful technique for obtaining an optimum raingauge network reduction. With respect to some specified accumulation time T and land area A, the areal mean rainfall depth Y is estimated. It is applicable when real estimation error is negligible for the unreduced raingauge network, for which Y can be written as the weighted mean of recorded rainfall depths. As an illustration of the type of results yielded by this procedure, the method was applied to monthly rainfall data collected from nine gauges over a 7 yr time span from a small catchment. (Baker-IVI)
W85-05541

COMPARISON OF DAILY AND WEEKLY PRECIPITATION SAMPLING EFFICIENCES USING AUTOMATIC COLLECTORS,
Geological Survey, Lakewood, CO.
For primary bibliographic entry see Field 7B.
W85-05694

CONDITIONAL DISTRIBUTIONS OF NEYMAN-SCOTT MODELS FOR STORM ARRIVALS AND THEIR USE IN IRRIGATION SCHEDULING,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
J. A. Ramirez, and R. L. Bras.
Water Resources Research, Vol. 21, No. 3, p 317-330, March, 1985. 7 Fig, 4 Tab, 30 Ref. NSF grants 78-20245 ENG and CEE8211469.

Descriptors: *Rainstorms, *Irrigation scheduling, *Neyman-Scott models, *Rainfall distribution, *Irrigation programs, *Scheduling, Statistical analysis, Model studies, Poisson models, Mathematical studies.

Storm arrivals were modeled with the cluster point process Neyman-Scott (N-S) model. The implied dependence between storms was represented by the conditional distribution of the occurrence of future events given a history of the timing of past events. The deficit irrigation scheduling problem was solved assuming that rainfall arrivals obey a N-S cluster model. This new result was used on a physicostochastic model of the soil moisture history which in turn leads to an optimal control algorithm for making irrigation decisions. The decision of when and how much to irrigate now depends on measured soil moisture, available irrigation water, and time since the last rainfall occurrence. Results of a case study show no important difference between the theoretical net benefits derived from assuming a homogeneous independent Poisson model or a dependent N-S model during the growing season. A nonhomogeneous Poisson model yields higher theoretical benefits. As expected, the conditional N-S model leads to improved irrigation control as compared to the unconditional N-S model. No definite conclusions can be drawn regarding whether the Neyman-Scott model better represents the process of storm arrivals as opposed to the Poisson model. (Collier-IVI)
W85-05795

HYDROGRAPH SENSITIVITY TO STORM KINEMATICS,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
G. G. Ngirane-Katashaya, and H. S. Wheater.
Water Resources Research, Vol. 21, No. 3, p 337-345, March, 1985. 10 Fig, 1 Tab, 10 Ref.

Descriptors: *Hydrographs, *Rainstorms, *Kinematics, *Model studies, *Rainfall-runoff relationships, Runoff, Urban runoff, Rainfall distribution.

The magnitude of the effect of storm field distribution on the hydrograph will depend on catchment response which in turn will vary with catchment size, topography, geology, and land use. Using synthetic urban catchments, represented by a distributed nonlinear rainfall-runoff model, a comprehensive investigation was made of the effects of storm velocity and direction on the runoff hydrograph including variation of catchment area and response and considering alternative definitions of an equivalent stationary storm. The results, although specific to the rainfall-runoff model and catchment drainage configuration adopted, clearly show hydrograph sensitivity to storm speed and direction for each of the areas and response conditions examined. If storms occur with directional bias for a given catchment, as may often be the case, the implications of these results is that depending on the frequency distribution of storm speed, consistent underestimation or overestimation may occur. The results indicate a complex and potentially significant influence of storm kinematics for design practice. (Collier-IVI)
W85-05797

COLLECTION OF FOG DRIP,
San Jose State Univ., CA. Dept. of Meteorology.
J. Goodman.
Water Resources Research, Vol. 21. No. 3, p 392-394, March, 1985. 2 Fig, 1 Tab, 14 Ref.

Descriptors: *Fog, *Atmospheric water, *Clouds, *Meteorological data collection, Rainfall, Hydrologic data, Data collection.

Fog and low stratus clouds are the dominant climatic feature along the central California coastline during the summer months. This moisture source is not only a critical feature in the local hydrologic cycle, but may prove to be a valuable source for augmenting the water supplies. During the summer of 1982 an experiment was conducted to examine the relative efficiency of two man-made fog collection systems, the harp and cylinder. The systems were designed to maximize the collection of water droplets on vertically strung wires. The systems collected a rain gauge equivalent of between 25.2 and 80.4 cm/unit vertical area as compared to the mean annual rainfall of 60 cm. (Author's abstract)
W85-05802

2C. Snow, Ice, and Frost

MECHANISMS OF PLASTIC DEFORMATION OF POLYCRYSTALLINE ICE (MECANISMES DE LA DEFORMATION PLASTIQUE DE LA GLACE POLYCRISTALLINE),
Laboratoire de Glaciologie et Geophysique de l'Environnement, Grenoble (France).
P. Duval.
La Houille Blanche, Vol. 6/7, p 499-503, 1984. 2 Fig, 16 Ref.

Descriptors: *Ice, *Plastic deformation, *Polycrystalline ice, *Deformation, Basal slip, Liquid inclusions.

The microscopic processes that control the plasticity of polycrystalline ice are discussed. Basal slip does not control the plastic flow of the polycrystals. The processes of restoration that enable a static state to be established are analyzed across the temperature range 0 - 5 C. The role of liquid inclusions in the ice of temperate glaciers is discussed in particular. The high level of plastic anisotropy in the ice explains the establishment of an internal stress field with peaks of amplitude several times higher than the stress applied. The initiation of dynamic recrystallization for distortions of less than 1% is explained. For low stresses, a 'superplastic' type behavior may occur if the joints of the particles migrate during distortion. (Author's abstract)
W85-05018

FINDELEN GLACIER; RAPID ADVANCE AND CONSTRUCTION OF A NEW SUBGLACIAL WATER CATCHMENT (GLACIER DE FINDELEN; AVANCE RAPIDE ET CONSTRUCTION D'UN NOUVEAU CAPTAGE SOUS-GLACIAIRE),
Grande Dixence Societe Anonyme, Sion (Switzerland).
A. Bezinge.
La Houille Blanch, Vol. 6/7, p 505-514, 1984. 5 Fig, 25 Ref.

Descriptors: *Findelen Glacier, *Catchment basins, *Glaciohydrology, Glacier surges, Hydrology, Surges.

Following a historical overview of the development of the glacier, and of the characteristics of the sloping basin, there is an analysis of the catchment points, taking account of hypotheses on glacial and hydroglaciological flows. The principle of catchment is then developed for the two banks. A few details of the work are given and a number of special comments are made. (Author's abstract)
W85-05019

USE OF AERIAL PHOTOGRAMMETRY FOR TRADITIONAL SURVEYS OF FLUCTUATIONS IN GLACIAL SPITS (UTILISATION DE LA PHOTOGRAMMETRIE AERIENNE POUR LES RELEVES TRADITIONNELS DE FLUCTUATIONS DES LANGUES GLACIARES),
Centre National de Machinisme Agricole du Genie Rural, des Eaux et des Forets, Saint-Martin-d'Heres (France). Div. Glaciologie.
R. Burnet.
Houille Blanche, No. 6/7, p 515-517, 1984. 2 Tab.

Descriptors: *Glaciers, *Aerial photography, *Photogrammetry, *France, Data collections, Surveys.

An inventory is given of data stored at the Snow Surveying Division of CEMAGREF and made available to researchers. The photogrammetric survey consists of stereopreparation of aerial photographs with a network of visible reference points, and taking of aerial photographs at an altitude of more than 1,500 above the ground. The apparatus is in place for glaciers of three massifs in France: Mont Blanc, Savoie, and Oissans - Grandes Rousses. (Moore-IVI)
W85-05020

MEASUREMENTS OF GLACIAL FLUCTUATIONS IN THE FRENCH ALPS; COLLECTION OF DATA AND RESULTS (MESURES DES FLUCTUATIONS GLACIAIRES DANS LES ALPES FRANCAISES; COLLECTE DES DONNEES ET RESULTATS),
Laboratoire de Glaciologie et Geophysique de l'Environnement, Grenoble (France).
L. Reyanud.
La Houille Blanche, Vol. 6/7, p 519-528, 1984. 8 Fig, 16 Ref.

Descriptors: *Glaciers, *French Alps, *Mont-Blanc Massif, *Vanoise Massif, *Grandes-Rousses Massif, *Ecrins Massif, Glaciology, Slip speed, Model studies.

A description is given of glaciological measurements made every year on around ten glaciers in the French Alps, located in the Mont-Blanc, Vanoise, Grandes-Rousses and Ecrins massifs. These fluctuation measurements deal with annual variations in surface area, length, altitude, displacement and total amount, or more detailed information on the glacial bed such as slip speeds and water pressure. The use of these measurement results to establish evolution models and study glacial fluctuation is then discussed. The measure-

ments made are particularly interesting, in view of the fact that there has been a period of major glacial development over the past 20 years. (Author's abstract)
W85-05021

RHEOLOGY OF GLACIER ICE,
Cold Regions Research and Engineering Lab., Hanover, NH.
K. C. Jezek, R. B. Alley, and R. H. Thomas.
Science, Vol. 227, No. 4692, 15 March, 1985. 4 Fig, 13 Ref. NSF grant DPP-8306689.

Descriptors: *Antarctica, *Ross Ice Shelf, *Ice, *Rheology, *Stress, Temperature effects, Glaciers, Gravity, Ice shelf.

A new method for calculating the stress field in bounded ice shelves is used to compare strain rate and deviatoric stress on the Ross Ice Shelf, Antarctica. The analysis of the data obtained is in good agreement with a constitutive relation between the power law and creep for glacier ice with exponent equal to 3. The constant in the constitutive relation averaged over depth for central regions of the Ross Ice Shelf is 2.3 x 10 to the minus 23 power/second. Back stresses ranging up to 0.3 MN/sq m or higher, caused by the interaction of the ice shelf with pinning points and with its sides, are an important factor in ice shelf dynamics. (Baker-IVI)
W85-05112

COMPARISON OF FIELD DATA WITH THEORIES ON ICE COVER PROGRESSION IN LARGE RIVERS,
Laval Univ., Quebec. Dept. of Civil Engineering.
B. Michel.
Canadian Journal of Civil Engineering, Vol. 11, No.4, p 798-814, December, 1984. 10 Fig, 5 Tab, 24 Ref.

Descriptors: *Ice cover, *Ice formation, *Rivers, Glaciers, Theories, Hydraulics, Ice packing, Ice shoving, Fluvial processes, Frazil ice.

Existing theories on dynamic ice cover progression are reviewed, an additional one is proposed, and they are classified according to the physical mechanisms that are involved. Finally, they are compared with some existing field data for large rivers. Using the field measurements of ice condition for five cases of long river reaches, with a total of 144 measured sections, it has been possible to distinguish the various meaningful modes of ice cover formation. The mode of quasi-static cover formation has been consistently overlooked in the literature because of the impossibility to simulate it in models, but it is the major ice formation mechanism in rivers of most northerly locations. In temperate climates all means of ice cover formation will occur. To the existing known mechanims the concept of the ice packing criterion is added, which has much similarity with the mechanism of shoving and may be used when the ice cover is packing on a short distance from the edge, during the freeze-up period. The ice Froude number is the main simple analytical tool for determining frontal cover progression or packing. A different number is needed for shoving. Both numbers have been quantified with best fit values from the field data. The velocity of entrainment of frazil to form hanging dam has been confirmed to be between 0.6 and 1.4 m/sec, depending on the states of evolution of frazil. (Baker-IVI)
W85-05458

FLOW RESISTANCE OF ICE-COVERED STREAMS,
Windsor Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W85-05459

ICE JAM PREDICTION MODEL AS A TOOL IN FLOODPLAIN MANAGEMENT,
State Univ. of New York at Binghamton. Dept. of Geological Sciences.
P. L. Barnes-Svarney, and B. E. Montz.
Water Resources Research, Vol. 21, No. 2, p 256-260, February, 1985. 1 Fig, 3 Tab, 12 Ref.

Descriptors: *Ice jams, *Flood plain management, *Conklin, *New York, *Prediction, Flood plains, Water management, Watershed protection, Flood control, Temperature effects, Precipitation, Seasonal variation, Snowfall, Model studies.

The results of a preliminary analysis are presented that incorporates climatic variables into a predictive modeling technique: Wiener Filtering. The analysis is based on the premise that climatic factors have a direct relationship to the occurrence of ice jams. While application of this model will not resolve all problems, it is a tool that may be used in conjunction with other techniques to aid in the prediction of ice jam occurrences and ultimately in more refined floodplain delineation. Ice jam events are postulated to be directly related to seasonal precipitation, snowfall, temperature, and temperature fluctuations. Temperature appeared to have little effect on ice jam events in Conklin, New York. Monthly averages of temperature, precipitation, snowfall, and temperature deviation showed low error, but with a low filter length, there were too few predicted events. While 15 day data on temperature and precipitation showed a large number of predicted points, accuracy could not be checked. The primary result was that ice jam occurrence was predicted in Conklin, New York by using climatic data in certain combinations. The findings suggest that the Wiener Filtering technique may prove to be a useful tool to those concerned with communities that experience irregular ice jam occurrences, such as Conklin. (Baker-IVI)
W85-05504

PHYSICAL PROPERTIES OF SNOW (LES PROPRIETES PHYSIQUES DE LA NEIGE),
Centre d'Etudes de la Neige, Saint-Martin d'Heres (France).
D. Marbouty.
Houille Blanche, p 557-567, August, 1984. 13 Fig, 20 Ref.

Descriptors: *Snow, *Physical properties, *Review, Thermal properties, Optical properties, Electrical properties.

The article reviews composition variables and thermal, optical and electrical properties of snow. Macroscopic properties are examined here. Most of the variables, particularly those of a mechanical nature, vary in different orders of magnitude, since snow is a mixture of 2 to 3 phases (solid, gaseous and perhaps liquid) and the pressures and temperatures found are generally near to the triple point of water. (Author's abstract)
W85-05543

PHYSICAL AND CHEMICAL EVOLUTION OF SNOWPACKS ON THE CANADIAN SHIELD (WINTER 1979-1980),
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
H. G. Jones, and M. Bisson.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1786-1792, December, 1984. 3 Fig, 1 Tab, 10 Ref.

Descriptors: *Canadian Shield, *Snowpacks, *Snowmelt, *Laflamme watershed, *Quebec, Chemical properties, Physical properties, Snow, Crystals, Water quality.

In order to determine any possible relationship between the physical nature of snowpacks and chemical characteristics of meltwaters, an examination was made of the growth and decline of a snowfield in the small watershed of Laflamme Lake north of Quebec city, Canada. The chemistry of the stream waters was also studied. The mesostructure of a typical snowpack at Laflamme Lake is characterized by a succession of strata from previously fallen or redistributed snow in differing stages of metamorphism of snow crystal and grain microstructure and variable chemical composition. The chemical budgets for four snowpacks comprising a part of this snowfield showed that downward migration and rejection of chemical zones by the packs prior to, and during the early melt period, were observed even though snowfield physical dimensions were little changed. The mechanisms for these changes in periods of no meltwater flow are unknown, but may be associated with rejection of aerosols from snow crystals during varying stages of metamorphism. This activity in the snowpacks was reflected by the water quality changes monitored in streamwaters as the spring melt-season progressed. (Baker-IVI)
W85-05659

SUBGLACIAL HYDROLOGY AND SEDIMENT TRANSPORT AT BONDHUSBREEN, SOUTHWEST NORWAY,
Norges Vassdrags- og Elektrisitetsvesen, Oslo. Hydrological Div.
R. LeB. Hooke, B. Wold, and J. O. Hagen.
Geological Society of America Bulletin, Vol. 96, No. 3, p 388-397, March, 1985. 7 Fig, 1 Tab, 28 Ref.

Descriptors: *Glaciohydrology, *Sediment transport, *Bondhusbreen, *Norway, Hydrology, Ice-rock interface, Melting, Suspended sediments, Water pressure, Drainage patterns.

Tunnels driven in rock under the glacier Bondhusbreen in Norway, and thence upward to the ice-rock interface, provide a rare opportunity to study a subglacial drainage system. Early in the melt season, suspended sediment discharges in the subglacial water channels are large, and channels apparently change position. These effects are inferred to be a consequence of increased separation of ice from the bed due to increased water pressure. Water pressures are believed to be high at this time of year because water channels, having closed by plastic deformation during the winter when discharges are low, are too small to handle the increasing spring discharges. Water thus backs up in the channel system. Calculations suggest that further changes in channel position occur as discharges increase, because the potential energy released by the water is able to melt ice in the walls of channels faster than it is replaced by inward flow of ice. Channels can thus trend diagonally across the direction of glacier flow. Although such changes may occur at any time during the melt season in response to variations in discharge, there appears to be a seasonal evolution of the drainage pattern under Bondhusbreen that is repeated each year. These shifting channel patterns make the engineering task of locating and diverting water beneath glaciers more difficult than anticipated. (Author's abstract)
W85-05733

FLOW LAW FOR ICE IN POLAR ICE SHEETS,
British Antarctic Survey, Cambridge (England).
C. S. M. Doake, and E. W. Wolff.
Nature, Vol. 314, No. 6008, p 255-257, March, 1985. 2 Fig, 2 Tab, 17 Ref.

Descriptors: *Ice shelves, *Polar regions, *Ice flow, Mathematical equations, Arctic, Antarctic, Boreholes.

Glacier flow theories are commonly based on the assumption that ice is not a Newtonian fluid, but has a non-linear stress-dependent viscosity. A re-examination of the spreading of Antarctic ice shelves suggests that the data cannot define a unique flow law. Analysis of tilt data from four boreholes in the Arctic and Antarctic indicates that a linear law gives overall a more coherent explanation of the data and one which agrees better with ice-shelf data. On evidence available at present it is not necessary to use a non-linear flow law to describe the flow and deformation of polar ice sheets. (Moore-IVI)
W85-05735

EXPLORATION OF A RIGID ICE MODEL OF FROST HEAVE,
Cold Regions Research and Engineering Lab., Hanover, NH.
K. O'Neill, and R. D. Miller.
Water Resources Research, Vol. 21, No. 3, p 281-296, March, 1985. 16 Fig, 29 Ref. NSF grants ENG-77-17004 and CEE-8017422.

Descriptors: *Frost heaving, *Soil water, *Model studies, Frozen ground, Mathematical analysis, Thermodynamics, Pore water.

A numerical model which simulates frost heave in saturated, granular, air-free, solute-free soil was derived based on equations developed from fundamental thermomechanical considerations and previous laboratory investigations. Although adequate data are lacking for strict experimental verification of the model, simulations produce an overall course of events together with significant specific features which are familiar from laboratory experience. Simulated heave histories show proper sensitivities in the shapes and orders of magnitude of output responses and in the relations between crucial factors such as heave rate, freezing rate, and overburden. (Author's abstract)
W85-05791

COMPARISON OF THE THERMAL REGIMES FOR FREEZING AND THAWING OF MOIST SOILS,
Oklahoma Univ., Norman. School of Petroleum and Geological Engineering.
F. Civan, and C. M. Sliepcevich.
Water Resources Research, Vol. 21, No. 3, p 407-410, March, 1985. 1 Fig, 1 Tab, 8 Ref.

Descriptors: *Thermal regimes, *Frozen ground, *Soil water, *Thermodynamics, Soil types, Mathematical analysis, Differential equations, Numerical analysis.

The spatial and temporal temperature distributions were compared for freezing or thawing of moist soils undergoing freezing or thawing at a single temperature like coarse-grained gravel or sand or over a temperature interval like fine-grained silts or clays. The principle difference in the thermal physical properties of the soil are affected by the unfrozen water content. For the comparison, an enthalpy formulation in terms of dimensionless variables combined with similarity transformation and coordinate scaling was used to obtain accurate numerical solutions for heat conduction with phase change, irrespective of whether the transition occurs at a single temperature or over a temperature interval. The transformed ordinary differential equation is simpler and can be solved more accurately than the original partial differential equation. The accuracy of the solutions is dependent on the numerical method used. In the case of the finite difference method the accuracy is influenced by the sizes of steps in the spatial and temporal coordinates. (Collier-IVI)
W85-05806

2D. Evaporation and Transpiration

COMPARATIVE STUDY OF THE CLIMATOLOGICAL ESTIMATION OF POTENTIAL EVAPOTRANSPIRATION,
Meteorological Office, Poona (India).
S. Venkataraman, K. Subba Rao, and Y. Jilani.
Mausam, Vol. 35, No. 2, p 171-174, April, 1984. 2 Tab, 13 Ref.

Descriptors: *Evapotranspiration, *Climatic zones, *Pan evaporation, Plant water potential, Water demand, Vegetation, Crops, Agriculture.

A comparative study of potential evapotranspiration (PET) by various methods, viz., Penman, Monteith, and Thom and Oliver, in relation to mesh-covered class A Pan evaporation (EP) was conducted for 9 radiation stations situated in different agroclimatic zones. PET of Monteith is close to PET of Penman and hence Monteith's formula may be preferred as it would also be more convenient for computation. Computation of PET by Monteith's method for a tall crop is recommended for adoption in place of Penman's method. PET short crop would grossly underestimate the peak crop water demands while PET tall crop would give true peak water demand. EP data may by used where PET by modified Penman method is to be preferred. (Collier-IVI)
W85-05095

ESTIMATION OF WEEKLY POTENTIAL EVAPOTRANSPIRATION,
Meteorological Office, Poona (India). Agricultural Meteorology Div.
N. N. Khambete, and B. C. Biswas.
Mausam, Vol. 35, No. 2, p 209-212, April, 1984. 4 Fig, 2 Tab, 4 Ref.

Descriptors: *Potential evapotranspiration, *India, *Pune, *New Delhi, *Nagpur, *Jodhpur, Evaporation, Transpiration, Solar radiation, Seasonal variation.

Weekly potential evapotranspiration at New Delhi, Pune, Nagpur, and Jodhpur (India) were estimated by different methods: (a) interpolation of monthly values estimated by a modified Penman formula; (b) estimation by a modified Penman formula with weekly meteorological normals and measured net solar radiation as input data; (c) computation following the method given by Doorenbos and Pruitt (1975, Crop Water Requirements, Irrigation and Drainage paper, F.A.O. Rome, pp. 28-49.); and (d) estimation by a modified Penman formula with weekly meteorological normals and solar radiation obtained from tables. In all the stations the difference between B and D is always less than the other two methods. Values computed by using actual radiation data is always preferable but for most of the cases net solar radiation data is not available; in those places, method D could be used for estimation of PE values. Ratio of actual evaporation to potential evapotranspiration computed by method D ranges from 0.72 to 0.91. For practical purposes these values may be taken to be 0.75 to 0.90 during the monsoon season; during the post-monsoon season they may be taken to be from 0.75 to 0.80 in the semi-arid zone and from 0.65 to 0.70 in the arid zone. Using method D, PE was computed for 100 stations. (Collier-IVI)
W85-05099

DESERTIFICATION IN THE UNITED STATES, STATUS AND ISSUES,
Bureau of Land Management, Washington, DC.
J. E. Sabadell, E. M. Risley, H. T. Jorgenson, and B. S. Thornton.
Final Report, April 1982. 277 p, 34 Fig, 399 Ref, 15 Append.

Descriptors: *Soil moisture deficiency, *Deserts, *Desertification, Dynamics, Physical events, Soil water, Semi-arid land, Technology, *Climates, Social aspects.

This report is a one-time survey and assessment of important ongoing physical and social events which are affecting the quality of land resources in the extensive water-deficient areas of the Western States. Emphasis is placed on identification and description of dynamic processes set in motion or accelerated by man's actions which change the character of the land positively or negatively; of the technologies and institutional arrangements which have arisen to monitor the effects of man's actions in the more fragile parts of the country; of the mitigating and preventive actions available to land managers and the progress made in the combating desertification. The report provides a holistic view of the actions and interactions which can lead to desertification. Thus it includes summary information on component elements of the resource base drawn from more detailed and authoritative sources such as the Department of Agriculture appraisals of soil conditions.
W85-05125

COMPARISON OF EQUATIONS USED FOR ESTIMATING AGRICULTURAL CROP EVAPOTRANSPIRATION WITH FIELD RESEARCH,
Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
R. W. Hill, E. L. Johns, and D. K. Frevert.
Available from the National Technical Information Service, Springfield, VA 22161. Bureau of Reclamation, Technical Report, October 1983. 242 p, 30 Fig, 21 Tab, 36 Ref, 7 App.

Descriptors: *Evapotranspiration, *Estimating equations, *Agricultural engineering, *Stress, *Irrigation, Corn, Alfalfa, Water consumption, Lysimeters.

Research data on alfalfa water use and related yields were obtained for 10 sites in the Western United States. Similar research data was obtained for corn at eight sites. Four different types of research studies were available: lysimeter, line source sprinkler stress plots, and farm yield. Research alfalfa yields and corresponding ET (evapotranspiration) were assumed to be 20% greater than field attained yields and ET, based on experience. Similarly, corn research yields and ET were assumed to be 10% greater than field attained yields and ET. Yield versus ET relationships were derived from the available research data. These equations became the link between the research studies and anticipated farm conditions. They also served as a comparison standard for testing the accuracy of the various empirical ET equations. The equations were compared to the field attained ET value as derived from research yields and the production function at each of the various sites. There was no single equation, out of the 10 evaluated, that matched the field attained ET at all sites with satisfactory consistency. Thus, none of the equations could be selected for general application to all sites without a site correction factor.
W85-05131

ESTIMATING NONPOTENTIAL EVAPOTRANSPIRATION BY MEANS OF THE EQUILIBRIUM EVAPORATION CONCEPT,
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
J. A. Mawdsley, and M. F. Ali.
Water Resources Research, Vol. 21, No. 3, p 383-391, March, 1985. 6 Fig, 2 Tab, 33 Ref.

Descriptors: *Equilibrium evaporation, *Evaporation, *Evapotranspiration, *Model studies, Climatology, Soil water, Barley, Grasslands.

The usefulness of the Preistly-Taylor (Mon. Weather Rev., 100, 81-93, 1972) model was greatly increased by modifying it and applying it to nonpotential evapotranspiration using regularly regularly recorded data. The model was tested using three data sets from the United Kingdom: barley, turf, and rye grass. The results demonstrate that the model does not provide a full description of nonpotential evapotranspiration, but this does not mean that the model may not be useful in applied hydrology. To assess the model's potential in this respect the results were compared with those obtained from the Penman-Grindley model (a model widely applied in the United Kingdom at least). This comparison suggests that despite the model's deficiencies it should still prove useful in climates similar to the United Kingdom, and with further testing, in all climates. (Collier-IVI)
W85-05801

2E. Streamflow and Runoff

ESTIMATION OF DRAINAGE AREAS IN A HOMOGENEOUS LANDSCAPE,
Rutgers - The State Univ., New Brunswick, NJ. Center for Coastal and Environmental Studies.
J. D. Phillips.
Water Resources Bulletin, Vol. 20, No. 6, p 847-850, December, 1984. 2 Fig, 1 Tab, 12 Ref.

Descriptors: *Drainage area, *Watershed boundaries, *North Carolina, *Albemarle-Pamlico Peninsula, *Wetlands, Basins, Drainage patterns.

It is sometimes necessary to define drainage areas in homogenous landscapes, where non-arbitrary methods are not usable. In areas such as portions of the lower coastal plain of North Carolina where there is little or no topographic relief and where soils, vegetation, geologic structure and other factors are essentially uniform, identification of drainage basin boundaries is difficult or impossible. In the vast swamp and pocosin terrain of the Albemarle-Pamlico Peninsula, not even field sampling of microrelief, soil characteristics, and vegetation can be readily used to identify watershed boundaries. In such a homogeneous landscape, however,

assumptions may be made that the hydrologic and geomorphic controls over drainage basin development are constant within the area. If this is true the drainage area of a stream may be related solely to the stream length and factors governing the length-area relationship are also constant. A simple formula based on these assumptions and the gravity model was proposed which can be used to estimate drainage divides in a homogeneous landscape. Choosing the square as the distance function, the breaking point or drainage divide along a transect between two streams in a homogenous landscape is determined with the formula. The breaking point method of estimating drainage divides is arbitrary but is designed for use only in situations where all non-arbitrary methods of delineating drainage areas have failed or are not feasible. If the assumptions associated with a homogeneous landscape can be accepted, and if it is essential that drainage areas be defined, the method is useful. While arbitrary, it is superior to pure guesswork and does have some theoretical basis. (Collier-IVI)
W85-04990

USE OF A DAM BREAK MODEL TO ASSESS FLOODING AT HADDAM NECK NUCLEAR POWER PLANT,

Westec Services, Inc., Plymouth Meeting, PA.
J. S. Scherrer, and D. L. Chery, Jr.
Water Resources Bulletin, Vol. 20, No. 6, p 905-914, December, 1984. 8 Fig, 4 Tab, 13 Ref.

Descriptors: *Model studies, *Flood forecasting, *Dam failure, *Connecticut River, *Quabbin Reservoir, *Haddam Neck Nuclear Power Plant, *Power plants, Flood damage, Earthquakes, Flood peak.

Many nuclear power plants are located beside rivers for easy withdrawal of water for cooling purposes, but such locations also expose the plants to flooding; even greater flood hazards exist where plants are located downstream of large dams. An evaluation of the greatest depth of flood water that could be expected at a plant-site due to potential dam failure was conducted for the Quabbin Reservoir Dams (Massachusetts) which are 80 miles up the Connecticut River from the Haddam Neck nuclear power plant in Connecticut. The NWS DAMBRK model was selected for making the needed evaluations; it has provision for representing valley storage volumes, dams, bridges, and other encroachments and adding flows at various locations along the reach. The model uses the one dimensional equations of unsteady flow (St. Venant) which consist of conservation of mass and momentum equations. A postulated earthquake was assumed to fail the dams. In such an event, both Winsor Dam and Goodnough Dike are assumed to slump and then be overtopped by water impounded in the reservoir. The simultaneous failure of both dams by overtopping and downcutting would combine the discharge of both the Winsor and Goodnough breaches, and thus would be the most conservative and extreme case for assessment of the downstream consequences. The predicted flood peak would occur at 35.6 hours from the beginning of dam failure and would have a flow of 37,700 cfs. The elevation of this flood peak is approximately 28 ft msl, 7 ft above plant grade of 21.0 msl. The flood has a broad crest being nearly 28 ft msl for about 10 hours and flooding above plant grade would occur for approximately 68 hours. The findings of this analysis demonstrate that the plant is adequately protected from the consequences of the postulated flood event. The most significant amount of time and effort for this evaluation was needed to prepare the input information and calibrate the model. (Collier-IVI)
W85-04998

REGIONALIZATION AND PREDICTION OF FLOODS IN THE FRASER RIVER CATCHMENT, B.C.,

Saskatchewan Univ., Saskatoon. Dept. of Geography.
P. R. Waylen, and M.-K. Woo.
Water Resources Bulletin, Vol. 20. No. 6, p 941-949, December, 1984. 4 Fig, 3 Tab, 12 Ref.

Descriptors: *Flood forecasting, *Fraser River Catchment, *British Columbia, Forecasting, Partial duration series, Regional analysis.

Probability distributions that model the return periods of flood characteristics derived from partial duration series were tested in the Fraser River catchment of British Columbia. Theoretical distributions describing the magnitude, duration, frequency and timing of floods were found to provide a good fit to the observed data. The five estimated parameters summarizing the flood characteristics of each basin were entered into a discriminant analysis procedure to establish flood regions. Three regions were identified, each displaying flood behavior closely related to the physical conditions of the catchment. Within each region, regression equations were obtained between parameter values and basin climatic and physiographic variables. These equations provided a satisfactory prediction of flood parameters and allow the estimation of a comprehensive set of flood characteristics for areas with sparse hydrologic information. (Author's abstract)
W85-05002

FLOOD-INDUCED BED CHANGES IN ALLUVIAL STREAMS,

Universita di Reggio Calabria, Cosenza (Italy). Dipt. di Difesa del Suolo.
B. Sirangelo, and P. Versace.
Hydrological Sciences Journal, Vol. 29, No. 4, p 389-398, December, 1984. 5 Fig, 12 Ref.

Descriptors: *Streambeds, *Italy, *Illice, *Model studies, *Floods, Monte carlo method, Mathematical studies, Stream erosion, Channel morphology.

The streams of southern Italy are often characterized by alluvial beds formed by coarse non-cohesive material ranging from gravels to cobbles and boulders. Their hydraulic geometry is not well defined since the flow often moves from one side of the alluvial bed to the other, thus forming channels which in a short time may disappear. These streams are referred to as 'fiumare'. A stochastic model was proposed to describe flood-induced changes in cross sections of ephemeral streams with coarse bed-material. The model is based on the assumption that the real process can be described as a marked point process. The cumulative distribution functions of both the total change in a fixed interval of time and the maximum scour in the same period were examined. The model was run, using Monte Carlo techniques, with field data obtained from the experimental basin of the Illice stream, a small stream in southern Italy. The stochastic models take into account both the stochastic and the intermittent nature of the hydrological process causing bed modifications and the uncertainty in evaluating the effects of a single flood event. Longer records than were available for the experimental stream should enable the model to be further refined, thus ensuring its greater precision. (Collier-IVI)
W85-05004

TESTING THE APPLICABILITY OF THE CREAMS MODEL TO ESTIMATION OF AGRICULTURAL NUTRIENT LOSSES IN FINLAND,

L. Kauppi.
Vesientutkimuslaitoksen Julkaisuja, No. 49, p 30-39, 1982. 2 Fig, 5 Tab, 6 Ref.

Descriptors: *CREAMS, *Model studies, *Agricultural runoff, *Nutrient losses, *Erosion, *Sediment transport, *Hovi basin, *Vihti, *Finland, *Mathematical models, Pesticides, Nutrients, Nitrogen, Phosphorus, Runoff, Percolation.

CREAMS is a physically based simulation model that estimates runoff, erosion/sediment transport, plant nutrient and pesticide yield from field-sized areas. It was calibrated to Finnish conditions with data from the Hovi basin, situated in Vihti, about 30 kilometers west of Helsinki. The basin is totally agricultural and its area is 12 hectares. The calibration years were 1968 and 1969. Calculated and observed runoff values corresponded with each other quite well on a monthly and annual basis. In 1968 the total observed runoff + percolation was 267 mm and the corresponding value calculated by the model was 289 mm. In 1969 the values were 224 mm (observed) and 229 mm (calculated). The soil losses calculated by the model were small, but because there were no observations it was not possible to compare calculated and observed values. Nitrogen and phosphorus losses calculated by the model were significantly greater than the observed losses. This may be due to incorrect parameter values, because the values had to be estimated from the literature. On the other hand, the observations on nutrient losses may have given misleading values because of insufficient sampling frequency. (Author's abstract)
W85-05062

CHANNEL CHANGE, SEDIMENT TRANSPORT, AND FISH HABITAT IN A COASTAL STREAM: EFFECTS OF AN EXTREME EVENT,

Center for Natural Resource Studies, Berkeley, CA.
R. Coats, L. Collins, J. Florsheim, and D. Kaufman.
Environmental Management, Vol. 9, No. 1, p 35-48, January, 1985. 9 Fig, 7 Tab, 22 Ref.

Descriptors: *Zayante Creek, *San Lorenzo River, *Santa Cruz County, *California, *Streamflow, *Fish habitats, *Sediment transport, *Channels, Bankfull stage, Storms.

A study on sediment transport and channel change was conducted on Zayante Creek and the lower San Lorenzo River in Santa Cruz County, California. A rainstorm with a recurrence interval locally in excess of 150 years occurred during the study year, 1982 WY. Stream surveys indicated that significant aggradation occurred during and after the peak flood. Upper study reaches were substantially recovered after high flows of early April, but the lower study reaches still had significant filling of pools and burial of riffles by sand. Increases in width-depth ratio were minor and localized in upper reaches, but were significant in lower reaches. Large inputs of sand, primarily from landsliding, altered the sediment transport regime. A higher proportion of the bedload is now transported by lower flows than before the January event. Roads and sand quarries contributed significantly to sediment input to the stream. A proposed dam may alter the sediment transport regime of Zayante Creek. Mitigating the effects of this dam on downstream fish habitat may require occasional bankfull discharges. (Author's abstract)
W85-05069

CASE STUDY OF 1981 FLOOD IN THE GODAVARI RIVER,

Flood Meteorological Office, Hyderabad (India).
N. Pandharinath.
Mausam, Vol. 35, No. 2, p 195-198, April, 1984. 5 Fig, 1 Tab, 2 Ref.

Descriptors: *Floods, *Godavari river, *India, *Rainfall distribution, Rainfall intensity, River basins, Flood forecasting.

The river Godavari flows across the Deccan plateau rising in the Nasik district of Maharashtra and falls in the Bay of Bengal after travelling about 1465 km. The river was in a flood stage during 10 to 14 August 1981 from Tekra to Dowaleshwaram. Taking each sub-basin as a unit, depth area duration analysis of the 3-day storm was made to assess the contribution of the sub-basins to the flood. The actual 3-day storm average depth of rainfall was compared with that of normal average depth of rainfall of each sub-basin. Floods in the Godavari river in August 1981 were mainly due to heavy rainfalls over Indravati, Wainganga, Wardha and Penganga sub-basins under the influence of a cyclonic storm which moved across the northern part of the basin. Studies of other floods in the Godavari river may yield a method for predicting floods in the Godavari. (Collier-IVI)
W85-05098

CALCULATION OF INFILTRATION LOSSES OF STORM RUNOFF,
I. A. Svetlichnaya.
Water Resources, Vol. 11, No. 2, p 104-108, March-April, 1984. 1 Fig, 6 Ref. Translated from Vodnye Resursy, No. 2, p 44-48, March-April, 1984.

Descriptors: *Storm runoff, *Infiltration, *Mathematical equations, Model studies, Leaching, Moisture, Slopes, Differential equations, Overland flow, Wetness index, Soil physical properties.

One of the main components of the water-balance equation is the surface infiltration loss, consisting of the infiltration losses at the point of entry of the moisture and during overland runoff. There are two approaches to the solution of this problem in hydrology. The first is related to the use of differential equations describing the entry of moisture by means of a diffusion equation. The second approach is based on the use of physical statistical relations which are the result of processing data accumulated as a result of full-scale experiments. An attempt was made to reduce the determination of the dimensional quantities of the infiltration parameter and a second parameter to a determination of the corresponding dimensionless constants, making it possible to unify the treatment without tying the values of the empirical constants to a particular dimension. The method was used to determine parameters using experimental data from a series of studies on artificial sprinkling of small plots. Indices of wetness were used. Under conditions of the forest-steppe zone the problem of developing an index of wetness is greatly complicated as a result of intensive agricultural use of lands, because of differences in the soil discharge by various crops having substantially different growing seasons and water requirements. To use the method for calculating infiltration losses of storm runoff for soils with other hydrophysical properties, it is necessary to have experimentally established precipitation and runoff curves. (Baker-IVI)
W85-05153

ON-SITE INVESTIGATIONS AND NUMERICAL MODELING OF WIND SETUP AND SETDOWN PHENOMENA IN THE MOUTH REGION OF THE ENISEI RIVER,
E. P. Kotrekhov.
Water Resources, Vol. 11, No. 2, p 108-119, March-April, 1984. 4 Fig, 3 Tab, 15 Ref. Translated from Vodnye Resursy, No. 2, p 49-61, March-April, 1984.

Descriptors: *River mouth, *Wind setup, *Wind setdown, *Enisei River, *USSR, Velocity, Waves, Deltas, Water level, Water currents.

The development of waterpower engineering, water transportation, and possible use of water resouces of the basin of the Enisei River has caused increased study of the regularities of the wind setup and setdown in the mouth of the river. On site observations were carried out in August-September of 1972-1974 to obtain data on the dynamics of the flow in the mouth stretch of the river and in the Enisei Gulf during setup and setdown. One of the characteristics of the processes is the rhythmic character of the oscillations of the water levels and current velocities in conformity with changes in the anemobaric (wind pressure) conditions in the southern part of the Kara Sea and in the Enisei Gulf. Movements of water flow in this case were as a rule of a typical long wave character, namely movement of the oscillations themselves in space is observed and translation encompasses the entire column of the flow from the surface to the bottom. A more complete model of Enisei setup and setdown phenomona was examined which took into account the action of the wind, separation of the delta channel into major distributaries, and also natural storage. (Baker-IVI)
W85-05154

SURFACE FILMS AFFECTING VELOCITY PROFILES OF SLOWLY MOVING WATER IN OPEN CHANNELS,
Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center.
W. D. Kemper, A. S. Humpherys, and J. A. Bondurant.
Irrigation Science, Vol. 5, No. 4, p 235-250, December, 1984. 9 Fig, 4 Ref.

Descriptors: *Surface films, *Open-channel flow, *Velocity, Films, Drag, Water surface, Obstruction to flow, Air-water interface.

Pollen, organic fibers, etc. on the surface of irrigation ditches or furrows often remain still while water below the surface moves. Rates of movement of surface films and underlying water were measured using observable solid and liquid tracers. Water flow rate, surface width, water depth, and channel length were varied in flumes in which the water was allowed to flow over a broad weir crest at the tail end. In some runs the surface was blocked 5 cm in front of the weir. When a slow moving water surface is blocked, velocity of the surface film immediately upstream from the block decreases to a small fraction of its value when the surface is blocked, even though the average water velocity remains constant. Relatively slow motion of this surface imposes a drag on the liquid moving below the surface, with the liquid immediately below the surface film having essentially the same velocity as the surface film. When the flow cross section converged near the surface the fast moving water passing over the broad weir blade developed a pull force on the surface film that affected surface movement as far as two meters upstream from the weir. As water left a pipe and travelled downstream in a channel the resistance to deformation of the new surface film, as indicated by the velocity of the midchannel surface, increased for several minutes until it reached a steady state. Surface films and their effects were present in dirty irrigation water, clean well water, and distilled water that was delivered to a carefully cleaned and protected glass flume a clean laboratory. (Baker-IVI)
W85-05169

LIMNOLOGICAL STUDIES IN A CROSS-SECTION OF THE MIDDLE REACH OF PARANA RIVER, I: GEOMORPHOLOGICAL AND HYDROLOGICAL CHARACTERISTICS (ESTUDIOS LIMNOLOGICOS EN UNA SECCION TRANSVERSAL DEL TRAMO MEDIO DEL RIO PARANA, I: CARACTERES GEOMORFOLOGICOS E HIDROLOGICOS),
Instituto Nacional de Limnologia, Santo Tome (Argentina).
E. C. Drago.
Revista de la Asociacion de Ciencias Naturales del Litoral, Vol. 15, No. 1, p 1-6, September, 1984. 4 Fig, 6 Ref.

Descriptors: *Parana River, *Argentina, *Hydrology, *Geomorphology, Channel morphology, Bedforms, River beds, Flow discharge, Suspended sediments.

The cross-section named 'Perfil Toma de Aguas Corrientes de Parana' is located in the main channel 2.7 km upstream of Parana City (Entre Rios Province, Argentina) and its geographical coordinates are 31 degree 42' 34' S and 60 degree 29' 07' W. The cross-section is morphologically stable, quite deep (22 m) and wide (600 m) at average stages. It is either U-shaped or asymmetrically V-shaped and lacks of sand bars. Because of its morphometry the section constitutes a primary control point that has fixed through long periods of time. In this case, analysis of hydrographical charts periodically surveyed over 66 years confirm the stability of the channel in this part of the river. The sandy bottom has dunes up to 5 m height. These bedforms migrate downstream. The Parana River catchment area up to the studied section is 2,000,000 sq km, representing 78% of the total drainage surface (2,600,000 sq km). The annual mean discharge is 14,000 cu m/s, so that 88% of total valley water volume flows through this cross-section. The suspended sediment concentrations ranged between 58 mg/l and 600 mg/l and the average concentration was 276 mg/l. (Author's abstract)
W85-05172

FLOW RESISTANCE OF ICE-COVERED STREAMS,
Windsor Univ. (Ontario). Dept. of Civil Engineering.
S. P. Chee, and M. R. I. Haggag.
Canadian Journal of Civil Engineering, Vol. 11, No. 4, p 815-823, December, 1984. 6 Fig, 17 Ref.

Descriptors: *Channel flow, *Hydraulics, *Ice cover, Roughness, Velocity, Flow resistance, Channel morphology, Boundaries, Streamflow, Mathematical equations.

The underlying theory of the hydraulics of channel flow with a buoyant boundary as an ice cover is discussed. The velocity distribution is developed in two-dimensional covered channel flow using the Reynolds form of the Navier-Stokes equation in conjunction with the Prandtl - Von Karman mixing length theory. The division of the channel into two subsections is central to the theory. The functional relationship for the division surface is obtained from the developed velocity profile. The composite roughness of the channel is finally derived. Laboratory flumes were used to gain experimental verification of the developed theory. Seven cross-sectional shapes were used. Ice covers were simulated with polyethylene plastic pellets as well as floating plywood boards with roughness elements attached to the underside. The developed theory and laboratory confirmation affirms the existence of two subsection flows in a channel with a buoyant upper boundary such as an ice cover. To obtain hydraulic parameters in an ice-covered channel, it is important to determine the location of the divison surface and this can be achieved through an equation which is provided. The composite roughness of an ice-covered channel can be computed using another equation. Verification is limited mostly to seven laboratory channels. Prototype observations over a wider range of roughness are required. (Baker-IVI)
W85-05459

RATIONAL METHOD REVISITED,
Surrey District, Vancouver (British Columbia). Engineering Dept.
A. A. Smith, and K.-B. Lee.
Canadian Journal of Civil Engineering, Vol. 11, No. 4, p 854-862, December, 1984. 4 Fig, 17 Ref.

Descriptors: *Rainfall-runoff relationships, *Rational method, Mathematical equations, Storm runoff, Hydrology, Design criteria, Rainfall, Runoff, Infiltration.

In the wake of more sophisticated methods of analyzing rainfall-runoff events, the traditional rational method has fallen into disrepute, but the method continues to be used in design offices. Some of the simple notions of the rational method are demonstrated to be useful in a way which yields more reasonable runoff hydrographs from complex storms and which represents the process of rainfall abstractions in a way that is a significant improvement on the crude application of a constant runoff coefficient. One of the standard procedures in the rational method is the choice of a storm duration equal to the time of concentration. The appropriate storm duration to maximize the required detention storage is dependent on rainfall abstractions, catchment response function, and other factors, and cannot be predicted by a general rule. Use of the rectangular response function implied by the rational method, in conjunction with uniform rainfall intensity, results in hydrographs of trapezoidal shape. A key feature of this approach is the determination of the time of concentration. The variation of the runoff coefficient C over the duration of rainfall has been fairly widely recognized. The volume-dependent runoff coefficient is undeniably empirical and cannot be claimed to represent the physical process of infiltration. It resembles the SCS infiltration method in that it assumes runoff to be proportional to precipitation but differs from the SCS equation in that it uses the dynamically varying soil storage potential instead of the initial value. (Baker-IVI)
W85-05460

REMOTE SEMIAUTOMATIC INSTRUMENTATION FOR INTERMITTENT STREAMFLOW MEASUREMENT AND SUSPENDED SEDIMENT SAMPLING,
Alberta Univ., Edmonton. Dept. of Geography.
J. L. Honsaker, I. A. Campbell, and R. B. Bryan.
Canadian Journal of Civil Engineering, Vol. 11, No. 4, p 993-996, December, 1984. 4 Fig, 4 Ref.

Descriptors: *Suspended sediment, *Channels, *Stream flow, *Measuring instruments, Automation, Ephemeral streams, Samplers.

Stream discharge and suspended sediment in ephemeral channels are measured by battery-powered instruments adapted for control by detection of rainfall. The research required a system of reliable, rugged semiautomatic instrumentation. Discharge is measured in a flow-rated Parshall flume using an Aquatot FMS 2280 sonic-echo flow gauge, designed to operate continually with a power line connection in urban storm drains or sewers, or industrial locations. It operates wholly out of the water, generating a sound pulse and detecting its echo from the water surface. Because of logistic problems with battery operation in the field during the 1981 and 1982 seasons, silicon solar cell panels were installed in 1983 to provide daily charging of the main power supply batteries. There was usually adequate time between events to recharge the battery. Suspended sediment was sampled automatically using a sequential sampler. (Baker-IVI)
W85-05461

LONGITUDINAL DISPERSION OF MATTER DUE TO THE SHEAR EFFECT OF STEADY AND OSCILLATORY CURRENTS,
Government Industrial Research Inst., Chugoku, Kure (Japan).
For primary bibliographic entry see Field 8D.
W85-05469

ANALYSIS OF RIVER WAVE TYPES,
Cold Regions Research and Engineering Lab., Hanover, NH.
M. G. Ferrick.
Water Resources Research, Vol. 21, No. 2, p 209-220, February, 1985. 6 Fig, 6 Tab, 20 Ref.

Descriptors: *Waves, *River flow, Stream flow, Saint-Venant equations, Unsteady flow, Model studies, Friction, Inertia, Mathematical equations.

A quantitative method was sought for identifying river wave types and an attempt was made to clarify the relationships between wave types. The analysis is based on the principle that the balance between friction and inertia determines river wave behavior. The Saint-Venant equations are combined to form a system equation. Written in dimensionless form, the system equation provides scaling parameters that quantify the magnitudes of all terms in the equation and indicate the relative importance of friction, inertia, and pressure gradient effects on a wave. By interpreting the scaling parameters probabilistically, additional data can be incorporated into the analysis to account for variable physical characteristics of a river and wave. This more general interpretation provides an improved estimate of the friction-inertia balance, insight into the continuous nature of transitions between wave types, and a measure of the reliability of wave type assessments near a transition. The scaling parameter ranges that correspond to each wave type and transition are identified with data from case studies. These case studies encompass a wide range of river and wave conditions, attesting to the general utility of the approach. (Baker-IVI)
W85-05500

SEPARATION OF THE SNOWMELT HYDROGRAPH BY STREAM TEMPERATURES,
Hokkaido Univ., Sapporo (Japan). Inst. of Low Temperature Science.
D. Kobayashi.
Journal of Hydrology, Vol. 76, No. 1/2, p 155-162, January, 1985. 5 Fig, 1 Tab, 7 Ref.

Descriptors: *Snowmelt, *Streams, *Water temperature, *Japan, *Hokkaido Island, Snow cover, Hydrographs, Surface flow, Subsurface flow, Runoff, Soil heat.

The temperature of a stream under thick snow cover in northern Hokkaido Island, Japan was 3 to 4 C during the snowmelt flood. This was considerably higher than the temperature of snowmelt and yet the stream was perfectly insulated from heat sources from above the snow cover. Thus, it was reasoned that soil heat was furnishing most of the heat in runoff. The fact that stream temperature does change during the latter half of recession flow, in spite of a decrease in the amount of runoff, suggests that the stream water is discharging from specified subsurface layers or from a network of underground water channels. The depression of stream temperature during high runoff rates was assumed to depend on mixing of the direct discharge of meltwater at 0 C with the indirect discharge of subsurface warm water at 3-3.5 C. The stream temperature of 3-3.5 C on the recession hydrograph resembles the soil temperature at the depth of about 1.5 m. The subsurface component is delayed a little but plays a much more active and significant role than the surface component in composing the snowmelt hydrograph, accounting for 93-94% of the total amount of runoff. Even in the peak discharge the contribution of the subsurface component is more than 80% and in the latter half of the recession discharge the total amount is occupied fully by the subsurface component. (Baker-IVI)
W85-05538

DESIGN DISCHARGES ESTIMATION FOR VARIOUS DESERT SITES NEAR THE DEAD SEA (ISRAEL),
TAHAL-Water Planning for Israel Ltd., Tel-Aviv.
For primary bibliographic entry see Field 2A.
W85-05539

ESTIMATION IN PARTIAL DURATION SERIES WITH INDEPENDENT AND DEPENDENT PEAK VALUES,
Technical Univ. of Denmark, Lyngby. Inst. of Hydrodynamics and Hydraulic Engineering.
For primary bibliographic entry see Field 4A.
W85-05540

STREAM ECOSYSTEM THEORY,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
K. W. Cummins, G. W. Minshaal, J. R. Sedell, C. E. Cushing, and R. C. Petersen.
Verhandlung Internationale Vereinigung Limnologie Vol. 22, No. 3, p 1818-1827, December, 1984. 1 Fig, 6 Tab, 34 Ref.

Descriptors: *Riparian vegetation, *Ecosystems, *Streams, Lotic environment, Vegetation, Organic matter, Scour, Drought, Reviews.

The major tenet of this paper is that stream and river-side vegetation, the riparian zone, exerts the primary control over biotic associations. This control is mediated both through physical channel influences and the nature of the organic inputs from outside the wetted channel or in stream plant growth. Such corridors of stream side vegetation are inseparable from the biology in the channel and constitute a ribbon of continuity responsible for many universally discernable patterns. Some selected examples of general attempts at classifying patterns in running waters and understanding their underlying controls are summarized. It follows logically that the characteristics of the streamside vegetation system, the riparian zone, constitute the major organizing function for biotic associations in running waters. Presumably most attempts at lotic paradigm building have been intended as models of at least classes of prototype streams. The primary impact of man has been to increase or decrease the impacts of natural events that change stream ecosystems. Within any of the periods of historical importance to stream ecosystems, a temporal perspective is essential. Annual peak discharge or drought can be viewed as reset mechanisms. For example, algal communities are scoured or dried in intermittent channels to very low population levels and resting stages, initiating an annual recolonization and sequential community development. Functional relationships in running water systems are discussed. (Baker-IVI)
W85-05662

ROLE OF WOOD DEBRIS IN MODIFYING CHANNEL GEOMORPHOLOGY AND RIPARIAN AREAS OF A LARGE LOWLAND RIVER UNDER PRISTINE CONDITIONS: A HISTORICAL CASE STUDY,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2J.
W85-05668

SUBMERGED MACROPHYTES AND THE HYDRAULIC ROUGHNESS OF A LOWLAND CHALKSTREAM,
Freshwater Biological Association, Wareham (England). River Lab.
For primary bibliographic entry see Field 2I.
W85-05675

RIVER BURE, UNITED KINGDOM: PATTERNS OF CHANGE IN CHEMISTRY AND PHYTOPLANKTON IN A SLOW-FLOWING FERTILE RIVER,
University of East Anglia, Norwich (England). School of Environmental Sciences.
B. Moss, H. Balls, I. Booker, K. Manson, and M. Timms.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1959-1964, December, 1984. 5 Fig, 1 Tab, 6 Ref.

Descriptors: *River Bure, *England, *Phytoplankton, *Chemical properties, Seasonal variation, River flow, Wetlands, Peat, Water chemistry, Broads.

The River Bure is one of three main rivers which drain northeastern Norfolk, England and which with their valley wetlands and over 40 flooded medieval peat pits constitute the Norfolk Broadland. The Bure, at its mouth, drains 931 sq km primarily of fertile agricultural land, underlain by glacial drift and chalk, and receives sewage effluent from over 50,000 people. Its long-term mean discharge in the stretch studied here is about 3 cubic m/second with a flowrate as low as 1 cm/sec in summer providing time for steady changes in downstream chemistry and phytoplankton to be observed. The main findings include a declining nitrate concentration downriver which is attributed to denitrification, considerable marl deposition and downstream changes in the phytoplankton communities. Increasing nitrate and P concentrations have been associated with the steady eutrophication of the river and it is hoped that restoration of aquatic plants may be achieved by phosphate precipitation at selected sewage treatment works. Nitrate control is not possible because of the diffuse sources. Phytoplankton crops at present appear to be controlled by flushing upstream of Hoveton Bridge and by N availability downstream. Substantal P reduction will be needed to reduce the algal populations. The pattern of phytoplankton community change cannot be explained entirely by changes in water chemistry. A possible explanation is that in the more vigorously flushed upstream sections, fast-growing small centric diatoms and flagellates may be selected for, while downstream the elongate, perhaps slower growing pennate diatoms and Oscillatoria sp. may be at a selective advantage in the less turbulent water. Subsequent effects of inhibition by substances secreted by the cyanophytes may also be important. The pattern is preserved and accentuated among the Broads which show wider ranges of flushing rates, and the observation may be useful to managers of riverine reservoirs wishing to maintain algal communities favored for the most economic treatment of drinking water. (Baker-IVI)
W85-05676

SEASONAL DYNAMICS OF WATER MOVEMENTS AND OF SUSPENDED MATTER IN A LARGE RIVER (DYNAMIQUE SAISONNIERE

DES MOUVEMENTS DE L'EAU ET DES PARTICLES EN SUSPENSION DANS UN FLEUVE),
Lyon-1 Univ., Villeurbanne (France). Section of Freshwater Ecology.
B. Cellot, and M. Bournaud.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 2002-2008, December, 1984. 4 Fig, 1 Tab, 9 Ref.

Descriptors: *Rhone River, *France, *Suspended solids, *River flow, *Sediment transport, *Seasonal variation, Organic matter, Particulate matter, Velocity, Flow discharge, Currents, Reservoir releases.

The water movements (discharge, current velocity) in the Rhone River, upstreams of Lyons (France), strongly modulate the transport of fine suspended matter and coarse organic particles. Measurements were carried out at 3 m from the river bank and in the middle of the channel, near the bottom and under the water surface. Stream velocities at different depths show a distinct correlation with the discharge values. Hence, water discharge can be used to describe the movements of the water at different levels of a river section. Whatever the discharge is, the flow rate near the river bank remains half as low as that of the channel; the flow rate in the channel is always maximum at a depth of 1 m from the surface; near the river bank it is maximum at half-depth. Suspended matter, of which the density is correlated with fluctuations in discharge, remains below 50 mg/l, except at the first water level increase in autumn, after the low water period (more than 100 mg/l). The same holds true for the suspended organic particles, with the density of about 0.1-0.3 mg/l, and particulate organic matter (P.O.M.) which at that time may attain 4 mg/l of dry matter; this phenomenon is reinforced by the leaf fall. Then, the successive winter floods bring about the loading of the river, which decreases progressively with the wash of the river bed. This loading of the river continues for a much longer period during the winter following the emptying of the hydroelectric reservoir upstream of Genissiat. The average amount of non-living material carried yearly by the river is estimated at 400,000 tons for the suspended matter and at 4,000 tons for the P.O.M. (Author's abstract)
W85-05681

SUBGLACIAL HYDROLOGY AND SEDIMENT TRANSPORT AT BONDHUSBREEN, SOUTHWEST NORWAY,
Norges Vassdrags- og Elektrisitetsvesen, Oslo. Hydrological Div.
For primary bibliographic entry see Field 2C.
W85-05733

PREDICTION OF COMBINED SNOWMELT AND RAINFALL RUNOFF,
Kanazawa Inst. of Tech. (Japan).
K. Mizumura, and C.-L. Chiu.
Journal of Hydraulic Engineering, Vol. 111, No. 2, p 179-193, February, 1985. 14 Fig, 8 Ref.

Descriptors: *Snowmelt, *Runoff, *Japan, *Sai River watershed, *Prediction, Tanks model, Kalman filtering, Autoregressive models, Model studies.

Snowmelt runoff forms an important water supply for the region of Japan facing the Sea of Japan where it is used to generate electricity, grow rice, and as drinking water. Snowmelt runoff in the spring is stored in reservoirs and, thus, an accurate runoff prediction is necessary for water level controls in the reservoirs. Rainfall runoff and snowfall-snowmelt processes were studied in the Sai River watershed southeast of Kanazawa, Japan. The combined snowmelt and rainfall runoff during the snowmelt period was predicted using a combination of the tanks and autoregressive models, with parameters identified by the Kalman filtering. The tanks model is represented by a cascading series of conceptual reservoirs. The input data used are rainfall, snowfall, runoff and air temperature. The uncertainty in parameter estimation for the tanks model can be reduced by using the Kalman filter. Even if the precipitation at the measuring station is not representative of the entire watershed, the autoregressive model coupled with Kalman filtering can give an accurate prediction of runoff. (Collier-IVI)
W85-05778

CHANNEL SCOURING POTENTIAL USING LOGISTIC ANALYSIS,
Wyoming Water Research Center, Laramie.
Y.-K. Tung.
Journal of Hydraulic Engineering, Vol. 111, No. 2, p 194-205, February, 1985. 5 Fig, 2 Tab, 13 Ref, 1 Append.

Descriptors: *Statistical analysis, *Channel scour, *Scour, *Logistic analysis, Statistical methods, Design criteria.

Occurrence of scouring in channels is a random phenomenon due to several factors including the fact that distribution of bed material is not uniform, channel geometry varies from one location to another, and flow is nonuniform. Water resource engineers often have to relate qualitative dependent variables to one or more independent variables, which may or may not be quantitatve. In the case of channel scouring, the dependent variable is the occurrence or nonoccurrence of scouring, which is binary and qualitative. In such circumstances, the use of conventional regression analysis would encounter a number of difficulties. Logistic regression was applied to a hydraulic problem of relating scouring potential in a channel to depth and velocity of flow. The problem was transformed by regressing the probability of occurrence of the dependent variable on independent varibles; thus the dependent variable is made continuous - to which ordinary regression analysis is less restrictive for application. A series of curves of different potential levels of scouring can be imposed on scatter diagrams of flow velocity and water depth for specific bed materials; these curves provide additional information to the designer and enhance risk-based design. Whether or not the methodology could become a useful addition in water resources engineering analyses further investigations and applications are necessary. (Collier-IVI)
W85-05779

MODELING OF UNSTEADY FLOWS IN ALLUVIAL STREAMS,
National Water Research Inst., Burlington (Ontario). Environmental Hydraulics Section.
B. G. Krishnappan.
Journal of Hydraulic Engineering, Vol. 111, No. 2, p 257-266, February, 1985. 2 Fig, 1 Tab, 16 Ref.

Descriptors: *Unsteady flow, *Model studies, *Computer models, *Alluvial rivers, Flow, Prediction, Boundary conditions.

A computer model was developed for the prediction of unsteady and nonuniform flows in alluvial streams. The model uses a generalized expression for evaluating the energy slope in mobile boundary flows. Therefore, it is possible to adopt different friction factor relationships into the model without affecting its structure. It is also possible to upgrade the model easily as new expressions for alluvial bed roughness become available. The model was tested for laboratory and field conditions and shows good agreement with measured data. It is capable of predicting longterm changes in riverbed slope and thus is well suited for estimating change in river regime caused by certain modifications to river flow, such as river diversions, meander cutoffs, river training works, dams and hydroelectric power plants. (Author's abstract)
W85-05782

COMPUTER ANIMATION OF STORM SURGE PREDICTIONS,
Ohio State Univ., Columbus. Dept. of Civil Engineering.
C. M. Libicki, and K. W. Bedford.
Journal of Hydraulic Engineering, Vol. 111, No. 2, p 284-299, February, 1985. 8 Fig, 14 Ref. NOAA contracts NA79AA-D-00120 and NA80AA-D-00103.

Descriptors: *Computer models, *Animation, *Storm surges, *Predictions, *Lake Erie, Graphical methods, Simulation, Water level.

With the proliferation of low-cost graphics systems and small computers, high-quality computer graphic representation of the modeling of geophysical flow is feasible. Storm surge activity on Lake Erie was simulated by a Leendertse-type model and the output from this model (water surface elevations) were pictured as three-dimensional surfaces in an animated sequence. Four methods for constructing such images were surveyed: A wire-frame plot on a line-drawing device; a representation as a set of flat panels on a polygon-drawing raster display; a smooth shaded rendering on a point-addressable monochrome display; and a full-color rendering with 'highlights' on a larger color palette display. Each of these methods were assessed in terms of speed, economy, reliability, the ability to render all relevant scales of activity, and the ability to be comprehended readily and unambiguously. (Author's abstract)
W85-05784

RIVER FLOW FORECASTING MODEL FOR STURGEON RIVER,
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
D. H. Burn, and E. A. McBean.
Journal of Hydraulic Engineering, Vol. 111, No. 2, p 316-333, February, 1985. 2 Fig, 2 Tab, 25 Ref.

Descriptors: *Sturgeon River, *Ontario, *River flow, *Forecasting, *Model studies, Snowmelt, Kalman filtering, Mathematical analysis, Algorithms, River forecasting, Seasonal variation.

A forecasting technique for predicting river flow resulting from combined snowmelt and rainfall was applied to measured data from the Sturgeon River, Ontario. The technique incorporates Kalman filtering techniques to reflect uncertainty in the measured data as well as errors in the system model. Utility of the forecasting algorithm was demonstrated when applied to a case study area. The methodology provided satisfactory forecasts of the one day ahead river flow resulting from rainfall and snowpack dissipation during the spring freshet period. The Kalman filter model has the advantage of having the model parameters recursively updated; this allows the model to simulate the effects of changing physiographic characteristics of the river basin on river flow. This 'learning' process is evidenced both through a decrease in the confidence limits of the forecasts as the season progresses and an increase in the certainty with which the model parameters are known, as reflected by a decrease in the confidence limits of the estimates of the parameter values. The adaptability of the model further allows it to reflect changes occurring within the river basin during the spring freshet period. (Collier-IVI)
W85-05786

FLOW DISTRIBUTION IN COMPOUND CHANNELS,
Queen Mary Coll., London (England).
P. R. Wormleaton, and P. Hadjipanos.
Journal of Hydraulic Engineering, Vol. 111, No. 2, p 357-361, February 1985. 2 Tab, 1 Ref.

Descriptors: *Flood plains, *Flow characteristics, *Compound channels, Compound hydrographs, Flow discharge, Channels, Model studies.

In an attempt to understand more fully the characteristics of flow in compound channels and to pinpoint more precisely the causes of discrepancies between observed and calculated discharges, the analysis of previous experiments were extended to an investigation of discharges through individual main channel/flood plain subdivisions. The data presented show that even though a calculation method may give a satisfactory value for overall discharge in a compound channel, the distribution of flow between main channel and flood plain may be badly modeled. In general, flood plain flows tend to be underestimated and this is compensated for to a greater or lesser degree by overestimated

main channel discharges. These errors in discharge distribution can lead to even greater inaccuracies in momentum and energy flux which could lead to problems in applying the dynamic flow equations. (Baker-IVI)
W85-05788

HYDROGRAPH SENSITIVITY TO STORM KINEMATICS,
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W85-05797

EMPIRICAL STUDY OF FLOOD MEASUREMENT ERROR,
Wisconsin Univ.-Madison. Dept. of Civil and Environmental Engineering.
K. W. Potter, and J. F. Walker.
Water Resources Research, Vol. 21, No. 3, p 403-406, March, 1985. 3 Fig, 3 Tab, 5 Ref.

Descriptors: *Flood profiles, *Hydrologic data collections, *Error analysis, Mathematical analysis, Statistical analysis, Streamflow, River flow.

At a gaging station, very large peak discharges are usually estimated by extending the rating curve or by making an indirect measurement; hence these discharges are subject to much larger errors than are directly measured discharges. A crude measure of the uncertainty of the largest observed peak discharge at a gaging station is the ratio of the largest directly measured discharge to the largest observed peak discharge. For 46 gaging stations in the State of Wisconsin this ratio ranges from 0.16 to 0.99, with a median of 0.72. For the annual flood series from the half of the gaging stations with lowest ratios, the coefficients of skewness have considerably higher mean and standard deviation than do those of the remaining flood series. These results are consistent with the impact of measurement error, though they can also be explained by the occurrence of single extremely large floods in several of the annual flood series. (Author's abstract)
W85-05805

NUMERICAL SIMULATION OF TURBULENT FLOWS,
National Aeronautics and Space Administration, Moffett Field, CA. Ames Research Center.
R. S. Rogallo, and P. Moin.
Annual Review of Fluid Mechanics, Vol. 16, p 99-137, 1984. 7 Fig, 99 Ref.

Descriptors: *Turbulent flow, *Numerical analysis, *Simulation, Fluid mechanics, Dynamics, Computers, Mathematical models.

Numerical simulation has become a viable complement to experiment in both fundamental and applied turbulence research. Its growing popularity reflects both its promise of realistic answers to a difficult problem and the continuing rapid decline in computing costs. This tend is expected to continue. In addition to the advances in computer capacity of the last decade, less easily measured progress has been made in simulation techniques and in the utilization of simulation results. A notable development in numerical algorithms has been the use of spectral methods for direct simulations in simple geometries. This method is not very attractive at present for complex LES (large-eddy simulation) calculations involving mesh mapping and implicit time advancement. The premise of LES, that turbulence calculations can be closed more easily by truncating scales of motion rather than statistical moments, is supported by results, especialy those in wall bounded flows. But the hope that very simple eddy-viscosity models would be sufficient has not proved correct for the anisotropic SGS (sub-grid scale) stresses caused by high mean field gradients, at least with a reasonable number of mesh points. Anisotropic meshes, which cause ambiguity in the definition of SGS length scales, and moderate Reynolds numbers, at which the roles of the various scales overlap, introduce additional modeling difficulties. The nature of the flow near walls requires the expensive resolution of very small scales. Inflow and outflow boundary conditions present a major obstacle in the calculation of complex engineering flows. The future of turbulence simulation appears bright indeed. While there remains work to do on simulation technique, modeling, and numerical methods, the point has already been reached of being able to generate more information than can be digested. The use of stored simulation results places fewer constraints on the questions that can be answered, and allows rapid interactive display of results. (Baker-IVI)
W85-05830

SECONDARY FLOW IN CURVED OPEN CHANNELS,
Universidad Central de Venezuela, Caracas. Inst. de Mecanica de Fluidos.
M. Falcon.
Annual Review of Fluid Mechanics, Vol. 16, p 179-193, 1984. 5 Fig, 24 Ref.

Descriptors: *Secondary flow, *Open channel flow, *Curved channels, Velocity, Uniform flow, Nonuniform flow, Eddy diffusion, Bed shear stress, Model studies.

Steady secondary flow in open-channel bends is reviewed. Specific consideration is given to both uniform and nonuniform curved flow. For the case of steady uniform curved flow in open-channel bends, reasonable distributions of the scondary-flow velocity have been obtained with a simple Boussinesq turbulence model. By using a depth-varying, scalar, eddy-diffusion coefficient together with the null-velocity condition at the channel bed it has been shown that the transverse velocity distribution is sensitive to the friction factor of the flow. For strongly curved nonuniform flows a k-e turbulence model was used which defines a Boussinesq, scalar, eddy-diffusion coefficient, and presents good predictions for some cases. A basic difference between the uniform and nonuniform analyses is that in the former it is assumed that the primary velocity component follows a logarithmic or power-law distribution, while in the latter this distribution is part of the calculation. While the use of simple Boussinesq turbulence models appears to yield acceptable transverse velocity distribuion, this does not seem to be the case for the transverse bed shear stress, which is an important quantity for predicting riverbed topography. It seems that better turbulence models will have to be developed before bank recession and the transverse bed shear stress can be calculated accurately. (Baker-IVI)
W85-05831

MATHEMATICAL MODELS OF DISPERSION IN RIVERS AND ESTUARIES,
Liverpool Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
P. C. Chatwin, and C. M. Allen.
Annual Review of Fluid Mechanics, Vol. 17, p 119-149, 1985. 2 Fig, 109 Ref.

Descriptors: *Estuaries, *River flow, *Mathematical models, *Dispersion, Channels, Open channel flow, Salinity, Reviews.

Good progress has been made recently on dispersion in rivers and open channels, evidenced by the frequent availability of potentially useful models for practically important questions. Progress on the more difficult question of dispersion in estuaries has been less satisfactory. Specific areas reviewed include basic principles of some dispersion models (ensemble means and time averages, effects of instrumentation, mechanisms of dispersion, Taylor's model of longitudinal dispersion, other types of dispersion models for conserved substances, dispersion of nonconserved substances); dispersion in rivers (dispersion soon after release, dispersion from steady sources, some geometrical complications); and dispersion in estuaries (one dimensional models of longitudinal dispersion in estuaries, modeling the longitudinal flux of salinity, the dependence of Km on salinity in estuaries). There should be more recognition of the potential shortcomings of standard techniques like the use of time averaged concentrations and eddy diffusivities, and of the limitations of standard models. Theoreticians should make more effort to present mathematical results in forms that make their importance obvious and to give detailed numerical examples of their application to real flows. Knowledge about dispersion could be significantly advanced by more well designed laboratory experiments. (Baker-IVI)
W85-05832

2F. Groundwater

GROUND WATER YIELDS AND INVENTORY FOR LAND-USE PLANNING IN CRYSTALLINE ROCK AREAS OF WAKE COUNTY, NORTH CAROLINA,
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
C. W. Welby.
Water Resources Bulletin, Vol. 20. No. 6, p 875-882, December, 1984. 10 Fig, 2 Tab, 12 Ref. Water Resources Research Institute of the University of North Carolina project A-120-NC.

Descriptors: *North Carolina, *Wake County, *Land use, *Groundwater management, *Regional planning, Planning, Water management, Resource management, Population density.

In urbanizing areas underlain by crystalline rocks an inventory of the usable ground water should form an important element in the land-use planning process. Land-use decisions are most often made upon water-well yield data alone, but these data do not address the inventory question. A method utilizing local geology, stream low-flow characteristics, and pumping test data permitted outlining portions of Wake county, North Carolina, which are more favorable and those which are less favorable for ground water supply development. Information from state-required 24-hour pumping test on 232 wells was supplemented by information from an additional 100 wells whose initial yields were determined by shorter pumping tests. Comparison of the ground water inventory values on a per acre or per square mile basis with average water use at various residential densities provides information useful to the responsible political body as it decides about population density distribution and the need for surface water supplies. For Wake County an average density of one residential unit per acre appears generally permissible before overdraft of the ground water supplies becomes a significant risk. By utilizing the ground water inventory and patterns of ground water yields from various rock types, county officials can maximize the effectiveness of public facilities funds. The technique appears useful for other parts of the Piedmont region of the southeastern United States. (Author's abstract)
W85-04994

BRIEF REVIEW OF KRIGING AND ITS APPLICATION TO OPTIMAL INTERPOLATION AND OBSERVATION WELL SELECTION,
Birmingham Univ. (England). Dept. of Civil Engineering.
T. S. Virdee, and N. T. Kottegoda.
Hydrological Sciences Journal, Vol. 29, No. 4, p 367-387, December, 1984. 18 Fig, 35 Ref.

Descriptors: *Kriging, *Observation wells, *Kennet Valley Chalk Aquifer, *United Permeability coefficient, Statistical analysis, Transmissivity, Interpolation, Regional discretization.

The current state of kriging in subsurface hydrology was critically reviewed. In an application to a region where boreholes already exist, methods of optimal location of additional observation wells for geophysical parameter investigation and optimal interpolation for the purpose of solving the inverse problem were investigated. The particular case of the location of wells for the measurements of transmissivity and hydraulic head in the Kennet Valley Chalk aquifer, UK, was examined. Results of interpolation of measured hydraulic conductivity values by kriging were compared with results from a standard graphical package for interpolation. Reference was also made to the distribution obtained by the inverse method (in which the conductivity distribution is obtained from the head

distribution). On the basis of the application, the conditional simulation (in which the generated data are both consistent with field values and the field statistical structure) was deemed to be the best. It was also found that different methods of interpolation give widely different distributions in the case of hydraulic conductivity. The kriged map or conditional map of the transmissivity should serve as the basis for regional discretization to which corrections via the inverse model may be made. (Author's abstract)
W85-05003

GROUND WATER DEVELOPMENT FOR MINERAL INDUSTRY IN ARID ZONES OF THE ANDEAN HIGHLANDS, SOUTH AMERICA,
Montgomery (Errol L.) and Associates, Inc., Tucson, AZ.
E. L. Montgomery, and J. W. Harshbarger.
Mining Engineering, Vol. 37, No. 1, p 45-48, January, 1985. 3 Fig, 9 Ref.

Descriptors: *Groundwater potential, *Water resources development, *Mineral industry, *Andes, *Chile, *Peru, *Bolivia, *Argentina, Arid zones, Mountains, Water quality, Transmissivity.

The region of metallic ore deposits in northern Chile, southern Peru, western Bolivia, and northwestern Argentina occurs in arid zones at altitudes as high as 6 km (19,700 ft). Because surface water supplies are meager, new mines require unexploited sources of water. Prolific ground water aquifers occur in salar basins in this region of the Andean Highlands. Exploration water wells have been constructed and aquifer characteristics have been tested in eight salar basins. Results indicate ground water quality is good. Aquifer transmissivity and storage computed from results of pumping tests indicate maximum capacities of more than 170 L/sec (2700 gpm) for individual production water wells. Results of investigations conducted by the authors demonstrate that ground water reservoirs in the Andean Highlands comprise a source of large quantities of water for the mineral industry. (Author's abstract)
W85-05045

HYDROGEOLOGIC AND GEOCHEMICAL STUDIES OF SELECTED NATURAL RADIOISOTOPES AND BARIUM IN GROUNDWATER IN ILLINOIS,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 2K.
W85-05122

USE OF URANIUM-SERIES ISOTOPES FOR STUDYING THERMAL WATERS OF THE FRUNZE REGION,
T. V. Tuzova, P. I. Chalov, R. S. Mangel'din, S. A. Tarasov, and V. I. Alekhina.
Water Resources, Vol. 11, No.1, p 84-89, January-February, 1984. 2 Fig, 2 Tab, 9 Ref. Translated from Vodnye Resursy, No. 1, p 156-160, January-February, 1984.

Descriptors: *Aquifers, *Frunze Region, *USSR, *Uranium radioisotopes, Thermal water, Groundwater recharge, Artesian basins, Hydrogeology.

In 1978-80 a pool of mineral waters occurring at depths of 900-202 m in Paleogene-Neogene deposits was discovered in the region of Frunze (USSR) as a result of exploratory drilling. The pool is located in the central part of the Chu intermontane artesian basin. Results of isotopic studies in the area revealed the absence of an interconnection of waters of the Paleogene-Neogene deposits with waters of the Quaternary deposits. Only in the Pliocene-Lower Quaternary aquifer, well 1240, is mixing of waters of a deep origin with waters of the upper aquifers not precluded. A well was drilled in the zone of a probable deep fault, but owing to its comparatively small depth it did not penetrate the fault and only tapped Pliocene deposits, the water content of which region was presumed to be negligible. The highest value of the ratio of U-234/U-238 was recorded in waters of well 1240. It is possible that this ratio of uranium isotopes characterizes waters of deep origin, which may or may not be connected with waters of the paleozoic rocks of the nothern slopes of the Kirgiz Range, but do participate in the formation of waters of the Paleogene-Neogene aquifer system. On the basis of the uranium disequilibrium it is easy to show that the portion of such waters in recharge of the systems is not more than 5%. (Baker-IVI)
W85-05150

ISOTOPE INVESTIGATIONS OF THE CONDITIONS OF FORMATION OF MINERAL AND THERMAL WATERS IN SOME CAUCASIAN REGIONS,
V. A. Polyakov, G. S. Vartanyan, and M. P. Ezhova.
Water Resources, Vol. 11, No. 2, p 95-104, March-April, 1984. 4 Fig, 2 Tab, 16 Ref. Translated from Vodnye Resursy, No. 2, p 32-43, March-April, 1984.

Descriptors: *Isotope studies, *Hydrology, *Caucasian Mineral Waters region, *Rioni Depression, *Black Sea, *USSR, Aquifer properties, Water analysis, Minerals, Meteoric water, Leaching, Hydrogeology, Thermal waters, Glaciers.

Natural isotope investigations are reviewed for the Caucasian Mineral Waters (CMW) region and the Black Sea artesian basin in the region of the Rioni depression. For mineral waters in the CMW region, in the stretch from the Narznov Valley to the northern boundary of the Koslovodsk deposit, the mineral waters are formed due to meteoric waters, which leach both the water-containing rocks of the sedimentary strata and the Paleozoic rocks of the crystalline basement. During circulation the waters are saturated with thermometamorphic carbon dioxide arriving from the basement along tectonic fracture zones. In the zone of the Essentuke deposit the saline-alkaline waters of the Lower and Upper Cretaceous deposits are typical of waters leaching from sedimentary rocks. No inflow of waters from the crystalline basement is noted. Possibly, the Essentuki waters are closely related hydrodynamically to the Lower Cretaceous waters of the Naguti zone. The Naguti deposit of saline-alkaline waters, confined to an aquifer in Upper Cretaceous deposits, is formed by mixing of metamorphic marine waters squeezed into this aquifer and meteoric waters arriving from the Lower Cretaceous aquifer and characterized by high dynamics. Data from the thermal waters of the Rioni Depression indicate that the aquifer is recharged by melting of glaciers of the Great Caucasus. The chemical composition of the waters is determined by processes of leaching of the water-bearing rocks and water exchange time in various parts of the artesian system. There is little inflow of water from the lower lying Jurassic deposits. The residence time of the water in various parts of the Neocomian system is estimated as from 500 to 10,000 years. Discharge of the subsurface waters of the Cretaceous deposits into ground-waters of the Rioni depression is observed. (Baker-IVI)
W85-05152

SENSITIVITY ANALYSIS APPLIED TO UNSATURATED FLOW MODELING OF A RETORTED OIL SHALE PILE,
Battelle Pacific Northwest Labs., Richland, WA.
M. D. Freshley, A. E. Reisenauer, and G. W. Gee.
Soil Science Society of American Journal, Vol. 49, No. 1, p 28-34, January-February, 1985. 9 Fig, 2 Tab, 28 Ref. DOE contract DE-AC06-76RLO 1830.

Descriptors: *Oil shale, *Unsaturated flow, *Solid wastes, Water pollution sources, Model studies, Sensitivity analysis, Precipitation, Vegetation, Evapotranspiration, Drainage, Permeability coefficient.

A method for systematic determination of sensitivity was applied to a model of water movement through retorted oil shale waste or spent shale. The resulting sensitivity equations are linear and were normalized by relative magnitudes of input to and output from the flow model to facilitate comparison between variables. A comparison of two submodels for water uptake by vegetation was also included because such models do not lend themselves to systematic analysis. The systematic method was applied by considering changes in annual totals of drainage, evaporation, and transpiration as well as changes in water flux over depth and time as indicators of model sensitivity. The sensitivity analysis applied to the study of water movement through spent shale determined sensitivity of the model to selected input parameters. The relative sensitivities can be used to determine which model input parameters should be carefully measured and which can be estimated. Results of the analysis demonstrate that the model of flow through spent shale is most sensitive to precipitation, meteorological data used to estimate potential evapotranspiration, initial conditions of the materials, and rooting depth and density. Consequently, efforts should be directed toward accurately measuring these parameters. Insensitivity of the flow model to hydraulic conductivity suggests that order of magnitude errors in measuring hydraulic properties of materials can be tolerated. Similarly, insensitivity of the limits of the sink term indicates that these parameters can be estimated. (Baker-IVI)
W85-05181

CHARACTERIZATION OF WATER FROM LAVERKIN SPRINGS, UTAH,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
For primary bibliographic entry see Field 2K.
W85-05309

MODELING THE INTERRELATIONSHIP OF GROUNDWATER AND SURFACE WATER,
Geological Survey, Lakewood, CO.
T. C. Winter.
In: Modeling of Total Acid Precipitation Impacts. 1984. p 89-119, 11 Fig, 58 Ref.

Descriptors: *Groundwater, *Model studies, *Surface water, *Mathematical studies, *Surface groundwater relations, *Groundwater movement, Numerical analysis, Acidification, Chemical properties, Acid rain, Hydrologic models, Simulation analysis, Theoretical analysis.

The interrelationship of groundwater and surface water is reviewed to make researchers involved in acid precipitation aware of the interaction of the two. Because of the complexity of analytical models, many researchers use changes in surface water levels to derive the interrelationship of groundwater and surface water. With the development of numerical simulation, more complex problems could be solved. Computer-simulation studies have identified a stagnation point at which the hydraulic head along a boundary is at a minimum. Sampling of groundwater for chemical analysis needs to be done with consideration of groundwater flow systems and hydrogeochemical processes. Surface water bodies reflect chemical contributions from groundwater sources more quickly than previously believed, probably due to increase in height of nearby groundwater mounds following infiltration directly adjacent to surface water bodies.
W85-05318

GROUND-WATER MODELING,
GeoTrans, Inc., Reston, VA.
J. W. Mercer, and C. R. Faust.
National Water Well Association, Worthington, OH., 60 p. 47 Fig, 8 Tab, 124 Ref, 5 Append.

Descriptors: *Model studies, *Groundwater, *Aquifer testing, *Mathematical analysis, Mathematical equations, Mathematical models, Mathematical studies, Numerical analysis, Groundwater pollution, Computers, Artesian flow, *Groundwater movement, Finite difference methods, Finite element method.

This report is directed towards managers and hydrologists with little or no modeling experience. It not only explains basic concepts in mathematical and numerical methods, but also presents the limi-

tations and uses of groundwater models as they are applied to help solve complicated ground-water problems. The chapters are arranged as follows: 1) overview; 2) mathematical models; 3) numerical models; 4) applications; and 5) recent developments. This book, by itself, is not sufficient to perform a modeling study; it is designed to be used with other, more detailed references.
W85-05351

APPLICABILITY OF EFFECTIVE PARAMETERS FOR UNSTEADY FLOW IN NONUNIFORM AQUIFERS,
Cornell Univ., Ithaca, NY. Dept. of Civil and Environmental Engineering.
A. I. El-Kadi, and W. Brutsaert.
Water Resources Research Vol, 21, No. 2, p 183-198, February, 1985. 14 Fig, 2 Tab, 31 Ref. NSF grant INT-8213639.

Descriptors: *Groundwater flow, *Aquifer properties, *Unsteady flow, Riparian aquifers, Spatial distribution, Temporal distribution, Simulation, Stochastic process, Permeability coefficient.

Spatial and temporal variability of water movement is studied in riparian aquifers and the limitations of the concept of effective parameters commonly used to represent an aquifer with spatially variable material properties as a uniform and homogeneous one are assessed. The stochastic approach, that is the assumption that the flow domain is a collection of multiple samples from a stochastic model, is suitable primarily for solving variability problems if uncertainty exists due to insufficient data. To reduce uncertainty of output variables, a conditional simulation may be used to describe input variables. Because of the difficulty in using a more rigorous approach with partly saturated flow and with compressibility effects included a modified form of the linearized Boussinesq equation was used in the analysis. A Monte-Carlo technique was used in the stochastic analysis of unsteady gravity drainage flow. The results of the transient flow problem showed the independent nature of both the variability of the output variables and of the values of the effective parameters. Only under certain conditions is it possible to define a single set of effective parameters to reproduce the median outflow hydrograph. The effective parameters were found to depend on both the distribution of the hydraulic conductivity and its spatial correlation. (Baker-IVI)
W85-05498

MULTICRITERION NETWORK DESIGN USING GEOSTATISTICS,
Arizona Univ., Tucson. Dept. of Systems and Industrial Engineering.
I. Bogardi, and A. Bardossy.
Water Resources Research, Vol. 21, No. 2, p 199-208, February, 1985. 7 Fig, 2 Tab, 41 Ref. NSF grant CEE 8110778.

Descriptors: *Geostatistics, *Network design, *Multicriterion decision making, Aquifers, Aquifer properties, Porosity, Algorithms, Computers.

A design method is presented for observation networks aimed at measuring several spatially correlated and anisotropic parameters of different importance. The decision variables are network density, distance between observation points for the various parameters, and observation effort. In the study geostatistics and multicriterion decision making (MCDM) have been combined in order to find an observation network trading off estimation accuracy and observation effort. Several parameters exhibiting geostatistical characteristics can be accounted for. The Composite Programming method appears a compromise objective for the statistical criteria and another compromise objective for the observation efforts criteria, then seeks for a trade-off between the two compromise objectives. An adjustment algorithm has been developed to be able to use the approach for expanding an existing network. The approach is simple and the algorithm may be implemented on minicomputers. A cost effective exploration network has been designed for a two layer aquifer system. This design is quite robust with respect to variogram parameters and changes in the weight set assigned to the parameters. (Baker-IVI)
W85-05499

VARIATIONAL-LAGRANGIAN ANALYSIS OF AQUIFERS WITH APPLICATION TO ARTESIAN WELLS,
Royal Academy of Belgium, Brussels.
M. A. Biot, and A. Delmer.
Water Resources Research, Vol. 21, No. 2, p 249-255, February, 1985. 6 Tab, 9 Ref.

Descriptors: *Aquifer properties, *Wells, *Artesian wells, Mathematical equations, Drawdown, Thermodynamics, Pumping, Finite element method.

A unifying variational principle of virtual dissipation of wide interdisciplinary generality is discussed in the more restricted context of aquifer analysis. It is applied to artesian well problems one with constant drawdown, the other with constant pumping rate for both small and large well capacity. The basic variational procedure involves a new approach to irreversible thermodynamics which is discussed and illustrated in the restricted context of aquifer analysis. The artesian well problems treated are intended to indicate how these methods may be applied to aquifers and the accuracy which can be expected. Numerical results have been obtained for values of the drawdown as a function of the distance from the well which are not available in the present literature. For sufficiently large values of time the influence radius is given by the same approximate value for all three problems irrespective of conditions at the well. The same conceptual approach may be used to deal with more complex geometries, multiple and inclined aquifers, incomplete wells, mixed free surface and confined systems. In addition, the more general thermodynamic theory provides means of treating problems which involve thermal and physical-chemical properties with filtering, convection diffusion, and adsorption. The procedure leads to a large variety of finite element methods by using as generalized coordinates values of the fields at the nodes of a grid with polynomial interpolations at intermediate points. (Baker-IVI)
W85-05503

NEW TYPE OF CURVE METHOD FOR THE ANALYSIS OF PUMPING TESTS IN LARGE-DIAMETER WELLS,
Institute of Hydrology, Wallingford (England).
R. S. Wikramaratna.
Water Resources Research, Vol. 21, No. 2, p 261-264, February, 1985. 3 Fig, 4 Tab, 2 Ref.

Descriptors: *Pumping tests, *Wells, Aquifer management, Groundwater management, Water supply development, Confined aquifers, Drawdown.

An improved method is proposed for the analysis of pumping test data from large-diameter wells in confined aquifers. An example is given which illustrates some of the problems which arise with the existing method and which shows the advantages of the proposed method. The method makes use of the same analytical solution as the previously existing method of analysis, and it is therefore subject to the same set of assumptions and limiting conditions to the situations where it can be applied. The modified method, which is based on a new set of type curves, is superior to the old method. The main advantages are that it is easier to compare the fit of the different type curves, since the comparison can be made with less relative movement of the two plots. It is possible to interpolate visually between the values for beta for which type curves exist where the correct match is an intermediate value. The method eliminates possible spurious match points by the introduction of the matchlines. A convenient check is provided on the correct choice of the match line by the existence of two transmissivity estimates which must agree if the analysis is correctly carried out; in practice it is reasonable to expect them to differ by less than about 1%. This agreement will be found whenever the two matchlines coincide, regardless of the fit between the data and the type curve; thus it is a necessary but not a sufficient condition for a correct match. (Baker-IVI)
W85-05505

RECHARGE IN KARST AND DUNE ELEMENTS OF A SEMI-ARID LANDSCAPE AS INDICATED BY NATURAL ISOTOPES AND CHLORIDE,
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Soils.
G. B. Allison, W. J. Stone, and M. W. Hughes.
Journal of Hydrology, Vol. 76, No. 1/2, p 1-25, January, 1985. 12 Fig, 1 Tab, 43 Ref.

Descriptors: *River Murray, *South Australia, *Groundwater recharge, *Karst, *Dunes, Isotopic tracers, Chlorides, Semiarid lands, Sinkholes, Sand dunes, Groundwater movement, Calcrete, Sinkholes, Vegetation.

The rates and mechanisms of recharge were investigated an area where groundwater salinities are variable. The amount of salt stored in some of the landscape settings common in the Murray Basin in South Australia were also studied. The River Murray flows across the geological feature known as the Murray Basin, a shallow structural depression of Early Tertiary age. The study area contains examples of the landforms, surficial deposits, and vegetation found in the Mallee Region in South Australia. The two major landscape settings studied were calcrete flats with sinkholes and sand dunes overlying the calcrete. Five minor settings were investigated and identified as undisturbed calcrete, primary (older) sinkholes, secondary (younger) sinkholes, sand dunes with native vegetation and sand dunes with introduced pasture. Data from a limited series of boreholes were interpreted to suggest that recharge varied from in excess of 100 mm/yr for secondary sinkholes to less than 0.1 mm/yr beneath sand dunes with native vegetation. Recharge under the dunes has apparently increased by more than two orders of magnitude following clearing of the native vegetation about 50 yr ago. About 90% of a 10,000 sq km area has been cleared which has ensured that inflow of saline groundwater to the adjacent River Murray will increase and, in view of the amount of salt stored in both the unsaturated and saturated zones, will continue for a very long time. Profiles of the chloride concentration of soil water at sites where the inferred recharge is lowest are consistent with the hypothesis that there is in excess of 50,000 yr recharge stored in the thick unsaturated zone. Some evidence for changes in recharge rate over this time scale is seen. (Baker-IVI)
W85-05530

HYDROGEOCHEMISTRY OF THE MEADE THRUST ALLOCHTHON, SOUTHEASTERN IDAHO, U.S.A., AND ITS RELEVANCE TO STRATIGRAPHIC AND STRUCTURAL GROUNDWATER FLOW CONTROL,
Colorado Univ. at Colorado Springs. Dept. of Geology and Applied Earth Sciences.
A. L. Mayo, A. B. Muller, and D. R. Ralston.
Journal of Hydrology, Vol. 76, No. 1/2, p 27-61, January, 1985. 9 Fig, 7 Tab, 51 Ref.

Descriptors: *Groundwater flow, *Aquifers, *Meade Thrust Allochthon, *Idaho, Hydrogeochemistry, Flow, Geohydrology, Isotope studies, Geochemistry, Calcium, Magnesium.

Classical geochemical and isotopic techniques were used to study groundwater flow patterns in the folded carbonate, sandy and shaly strata of the Meade thrust allochton, southeastern Idaho. Two major groundwater regimes were identified. Aquifers of the upper regime are restricted to strata above the Phosphoria Formation. Their waters circulate within a few hundred meters of the surface. Discharge waters are of recent meteoric origin, having temperatures of 12 C or less, and are generally undersaturated with respect to calcite, and have Ca/Mg of about 2.5. Groundwater flow is generally bedding plane controlled and discharge is along bedding and thrust splay surfaces. No indication was found of significant

groundwater circulation between this and underlying strata (tier two). Aquifers of the lower regime, tier two, are restricted to consolidated strata below the Phosphoria Formation which generally hydraulically isolates them from tier-one aquifers. Groundwater flow in tier two circulates as much as 1900 m below land surface. Discharge waters have temperatures up to 26 C. Groundwater flow is generally bedding plane controlled, and discharge is along deep-seated extension and thrust faults. Tier-two aquifers appear to be contained within the allochthon, with no evidence suggesting they communicate with deeper circulating systems. (Baker-IVI)
W85-05531

D/H VARIATIONS OF METEORIC WATERS IN ALBUQUERQUE, NEW MEXICO, U.S.A.,
New Mexico Univ., Albuquerque. Dept. of Geology.
C. J. Yapp.
Journal of Hydrology, Vol. 76, No. 1/2, p 63-84, January, 1985. 7 Fig, 2 Tab, 19 Ref.

Descriptors: *Meteoric water, *Albuquerque, *New Mexico, *Deuterium, *Hydrogen, Precipitation, Runoff, Surface waters, Snowmelt, Groundwater, Aquifer recharge, Little Ice Age.

Natural D/H variations were used to examine the relationships between precipitation, surface water and groundwater in Albuquerque, especially since there are no stable-isotope data on the waters in the Albuquerque vicinity and such a study would establish a preliminary data base. Data are provided along with a discussion on the natural variations of deuterium/hydrogen ratios in precipitation, river waters and groundwaters near the city. The various meteoric water components contributing to the hydrologic regime in Albuquerque exhibit a wide range of delta-D values. In additional to a horizontal variation in groundwater delta-D values, there is also evidence of vertical stratification of groundwater delta-D values within the western groundwater domain. The deeper groundwater component in the western domain apparently did not originate from modern Rio Grande recharge. Regional evidence of temporal variations in precipitation D/H ratios suggests the Little Ice Age as one interval when river waters might have been more negative than at present. If the deuterium-depleted deep groundwater actually did originate under different climatic conditions, it suggests that at least a portion of the groundwater in the study area is being mined. (Baker-IVI)
W85-05532

MOTION OF THE SEAWATER INTERFACE IN A COASTAL AQUIFER BY THE METHOD OF SUCCESSIVE STEADY STATES,
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
J. Bear, U. Shamir, A. Gamliel, and A. M. Shapiro.
Journal of Hydrology, Vol. 76, No. 1/2, p 119-132, January, 1985. 4 Fig, 1 Tab, 15 Ref.

Descriptors: *Coastal aquifers, *Groundwater flow, *Saline-freshwater interfaces, *Israel, Interfaces, Seawater intrusion, Groundwater manage ent, Mathematical models.

Approximate expressions have been developed for the motion of the interface toe, especially the linear one, for incorporation into a management model of an aquifer in which the location of the interface is one of the criteria. The management model is constructed as a linear program, and it was therefore important to have a linear expression for the motion of the interface. The management model that is developed focuses on the operation of the aquifer for one season or for one year, and therefore the validity of the approximation must be examined for this time period. There is considerable deviation between the approximate solution and the results of the numerical model. The approximate results are, however, indicative of the true movement for conditions encountered in the coast aquifer of Israel. (Baker-IVI)
W85-05535

BANK STORAGE CHARACTERISTICS OF A FINITE AQUIFER DUE TO SUDDEN RISE AND FALL OF RIVER LEVEL,
M. A. Gill.
Journal of Hydrology, Vol. 76, No. 1/2, p 133-142, January, 1985. 4 Fig, 1 Tab, 7 Ref.

Descriptors: *Aquifer properties, *Bank storage, *Groundwater movement, *Seepage, Boundary conditions, Model studies, Surface-groundwater relations, Water level.

Unsteady seepage flow in a two-dimensional water table aquifer is analyzed for recession/accretion due to a sudden rise or fall of water level in the adjoining river. The present solution will hopefuly widen the scope of the experimental research since most of the model aquifers are of finite length. Some boundary effects are bound to creep into the solutions which are valid for infinite aquifers but are used for finite ones. The one-dimensional solution is a particular case of the two-dimensional solution. The limitations under which one-dimensional solution can be used are also clearly elucidated in the two-dimensional solution. Where the aquifer is relatively thick and short, the one-dimensional solution cannot be used. The advantage of the solution for a finite aquifer is that it can also be used for infinitely long aquifers. The influence of the impervious barrier which delimits a finite aquifer in the x-direction can thus be eliminated. (Baker-IVI)
W85-05536

GENERALIZED WELL FUNCTION EVALUATION FOR HOMOGENEOUS AND FISSURED AQUIFERS,
British Geological Survey, London (England).
J. A. Barker.
Journal of Hydrology, Vol. 76, No. 1/2, p 143-154, January, 1985. 2 Fig, 17 Ref.

Descriptors: *Fissured aquifers, *Well function, *Evaluation, *Laplace equation, Fissure water, Geologic fractures, Aquifers, Drawdown.

The main conceptual ideas used in modelling fissured aquifers are reviewed. The solution to the problem of a pumping test using a large-diameter well is presented in a form which is relatively simple. The well function for a large-diameter well fully penetrating a fissured aquifer can be expressed in terms of the Laplace transform of the drawdown. This function contains, as special cases, many previously studied well functions for both fissured and homogeneous aquifers. Evaluation of drawdowns from this function can be achieved by numerical inversion of the Laplace transform; this provides a general method for computing a large range of well functions. Flow equations are presented followed by an outline of their solution. Only fissured aquifers are considered since homogeneous aquifers can be regarded as a special case where there is no matrix storage. (Baker-IVI)
W85-05537

ISOTOPE HYDROLOGY STUDY OF MOLAI AREA IN LACONIA,
Democritus Nuclear Research Center, Athens (Greece).
J. L. Leontiadis.
Report DEMO 81/4, April 1981. 67 p, 13 Fig, 5 Tab, 4 Maps, 18 Ref.

Descriptors: *Groundwater, *Aquifers, *Groundwater recharge, *Groundwater movement, *Geohydrology, *Groundwater runoff, *Groundwater storage, *Springs, *Isotopic tracers, Isotope studies, Fault springs, Reservoirs, *Greece.

The isotopic composition of the groundwater was used in order to investigate the mechanism of recharge of the Molai plain and the coastal brackish springs of the area. According to the results of this study and in contrast to the existing hydrological views at that time, the Tripolitza carbonates northeast of the plain do not form a unique aquifer nor contribute to the recharge of the plain, which is mainly fed by the local rainwater. The brackish springs at Glyfada are fed by the Tripolitza carbonates northeast of the Mavrovouni-Koupia fault, through an isolated spring from the neogene aquifer of the plain conduit. The water content of the corresponding reservoir was estimated in the range of 2318 to 3091 cu m. The brackish springs at Plytra are fed by the marbles of the Chavallas and Skardolakka mountains through the bedrock of the Assopos river and the neogene aquifer of that part of the plain. The water content of the corresponding reservoir was estimated to be more than 284 mega cu m. The brackish coastal springs between Palea Monemvasia and Hierax are fed by the Tripolitza limestones southeast of the Mavrouvouni-Koupia fault. The sinkhole southeast of Metamorphosis is located in these rocks.
W85-05595

ECOLOGICAL INVESTIGATIONS ON THE ALLUVIAL SEDIMENTS OF THE DANUBE IN THE VIENNA AREA - A PHREATOBIOLOGICAL PROJECT,
Oesterreichische Akademie der Wissenschaften, Vienna. Inst. fuer Limnologie.
For primary bibliographic entry see Field 2J.
W85-05656

SAPPING PROCESSES AND THE DEVELOPMENT OF THEATER-HEADED VALLEY NETWORKS ON THE COLORADO PLATEAU,
California Inst. of Tech., Pasadena. Guggenheim Jet Propulsion Center.
For primary bibliographic entry see Field 2J.
W85-05729

SIMULATION OF CHANGES IN GROUNDWATER LEVELS ASSOCIATED WITH STRIP MINING,
Alberta Univ., Edmonton. Dept. of Geology.
For primary bibliographic entry see Field 4C.
W85-05731

DISPLACEMENT OF CONNATE WATER FROM AQUIFERS,
Texas A and M Univ., College Station. Dept. of Geology.
P. A. Domenico, and G. A. Robbins.
Geological Society of America Bulletin, Vol. 96, No. 3, p 328-335, March, 1985. 5 Fig, 1 Tab, 16 Ref.

Descriptors: *Connate water, *Meteoric water, *Aquifers, Mathematical models, Geologic formations, Dispersion, Groundwater recharge.

A mathematical model is developed for the mixing of meteoric and original formation waters in homogeneous aquifers. The theoretical analysis indicates that geologic formations that have had a few to a few tens of pore volumes of meteoric water pass through them may be at steady state with respect to further displacement of their contained fluids. Depending on constraints in the recharge area, the steady state may vary from near meteoric water throughout the whole formation to a spatial variation in concentration ranging from meteoric water in the recharge areas to highly concentrated water at the discharged ends of the system. The former condition is attained when the recharge area incorporates the total depth and breadth of the formation. Where this condition is not satisfied, the concentrations that evolve are controlled by the original concentration of the formation water, the composition of recharging meteoric water, the dispersion parameters, and the size of the recharge area in comparison to the total breadth of the formation as measured along its strike. For heterogeneous formations, the concentration patterns that evolve seem to depend further on contrasts by hydaulic conductivity. This is demonstrated in the Milk River sandstone, which is characterized by several extensive zones of dilute water within narrow, high-conductivity pathways and marked increases in concentration in adjacent, lower-permeability rock. In parts of the aquifer where higher-permeability pathways appear to be absent, the isochlores form a broad linear band with a marked increase in concentration in the flow direction. (Author's abstract)
W85-05732

CONTINUUM MODEL FOR SIMULTANEOUS CHEMICAL REACTIONS AND MASS TRANSPORT IN HYDROTHERMAL SYSTEMS,
California Univ., Berkeley. Dept. of Geology and Geophysics.
P. C. Lichtner.
Geochimica et Cosmochimica Acta, Vol. 49, No. 3, p 779-800, March, 1985. 3 Fig, 2 Tab, 74 Ref, 4 Append. NSF grant EAR 81-15859 and DOE contract DE-AT03-83ER-13100.

Descriptors: *Hydrothermal studies, *Chemical reactions, *Mass transport, *Continuum models, Porous media, Groundwater movement, Mathematical equations, Solute transport, Permeability, Porosity, Advection, Dispersion, Diffusion, Shock waves.

A time-space continuum model for transport of hydrothermal fluids in porous media is presented which provides for simultaneous, reversible and irreversible chemical reactions involving liquids, gases and minerals. Homogeneous and heterogeneous reactions are incorporated in the model in a similar fashion through source/sink terms added to the continuity equation. The model provides for moving reaction fronts through surfaces of discontinuity across which occur jump discontinuities in the various field variables satisfying generalized Rankine-Hugoniot relations. Reversible reactions including aqueous complexing, oxidation-reduction reactions, mineral precipitation and dissolution reactions and adsorption and explicitly accounted for by imposing chemical equilibrium constraints in the form of mass action equations on the transport equations. This is facilitated by partitioning the reacting species into primary and secondary species corresponding to a particular representation of the stoichiometric reaction matrix referred to as the canonical representation. The transport equations for the primary species combined with homogeneous and heterogeneous equilibria result in a system of coupled, nonlinear algebraic/partial differential equations which completely describe the evolution of the system in time. Spatially separated phase assemblages are accommodated in the model by altering the set of independent variables across surfaces of discontinuity. Constitutive relations for the fluid flux corresponding to primary species are obtained describing transport of both neutral and charged species by advection, dispersion and diffusion. Numerical implementation of the transport equations is considered and both explicit and implicit finite difference algorithms are discussed. Analytical expressions for the change in porosity and permeability with time are obtained for an assemblage of minerals reacting reversibly with a hydrothermal fluid under quasi-steady state conditions. Fluid flow is described by Darcy's law employing a phenomenological expression relating permeability and porosity. Finally an expression for the local retardation factor of solute species is derived for the case of advective transport in a single spatial dimension which accounts for the effects of homogeneous and heterogeneous equilibria including adsorption on the rate of advance of a reaction front. The condition for the formation of shock waves is given. (Author's abstract)
W85-05762

GROUND WATER AS A SILICA SOURCE FOR DIATOM PRODUCTION IN A PRECIPITATION-DOMINATED LAKE,
Wright State Univ., Dayton, OH. Dept. of Geology.
For primary bibliographic entry see Field 2H.
W85-05775

COMPARISONS OF SUCCESSIVE ITERATION AND DIRECT METHODS TO SOLVE FINITE ELEMENT EQUATIONS OF AQUIFER CONTAMINANT TRANSPORT,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5B.
W85-05790

DETECTION OF LINEAR BOUNDARIES BY DRAWDOWN TESTS: A SEMILOG TYPE CURVE MATCHING APPROACH,
Stanford Univ., CA. Dept. of Petroleum Engineering.
A. Sageev, R. N. Horne, and H. J. Ramey, Jr.
Water Resources Research, Vol. 21, No. 3, p 305-310, March, 1985. 9 Fig, 1 Tab, 11 Ref.

Descriptors: *Drawdown tests, *Graphical analysis, *Drawdown, *Linear boundaries, *Reservoirs, *Aquifers, Wells, Permeability, Water level.

A new method for pressure drawdown analysis in reservoirs affected by linear boundaries was developed based on a semilog curve matching approach and may be applied to both constant pressure and impermeable linear boundary cases. A semilog type curve was derived by which the distance between a well and the linear boundary may be estimated. The new analysis method is an improvement over the current double straight line analysis method. The pressure response of the well is matched without the need to find two straight lines, and several advantages result. First, the analysis may be performed for interference tests for which the first semilog straight line never develops. Second, the duration of the test required for the new method is shorter by an order of magnitude than that required for existing semilog methods, since it is not necessary to wait for the second straight line to develop. (Author's abstract)
W85-05793

SEEPAGE TO COLLECTION GALLERY NEAR SEACOAST,
Canterbury Univ., Christchurch (New Zealand). Dept. of Civil Engineering.
B. Hunt.
Water Resources Research, Vol. 21, No. 3, p 311-316, March, 1985. 8 Fig, 2 Ref.

Descriptors: *Seepage, *Aquifers, *Groundwater movement, *Collection galleries, Drawdown, Wells, Saltwater intrusion, Conformal mapping.

Collection galleries (horizontal ditches or slotted pipes) are useful for abstracting large flows from aquifers without causing large drawdowns. One important use for galleries is along seacoasts where excessive drawdowns can cause seawater intrusion and pollution of the fresh water aquifer. Conformal mapping was used to obtain a solution for seepage to a collection gallery that is parallel to a seacoast. The solution permits calculation of the gallery drawdown that is required to withdraw any given flow rate and also allows calculation of the maximum flow rate that can be abstracted without causing sea water intrusion. In some applications there may be very little difference between the critical flow rates for a gallery and for a well. In general it will be easier to actually abstract this amount of flow with a gallery because of the relatively large aquifer contact area. (Collier-IVI)
W85-05794

HILLSIDE SEEPAGE: AN ANALYTICAL SOLUTION TO A NONLINEAR DUPUIT-FORCHHEIMER PROBLEM,
Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.
S. R. Yates, and A. W. Warrick.
Water Resources Research, Vol. 21, No. 3, p 331-336, March, 1985. 5 Fig, 2 Tab, 10 Ref, 1 Append.

Descriptors: *Mathematical problems, *Seepage, *Soil water, *Dupuit-Forchheimer theory, *Groundwater movement, *Aquifers, Unsaturated zone, Infiltration, Leakage aquifers, Leaky boundaries.

Dupuit-Forcheimer (DF) analyses have proven valuable for simplifying flow problems where a free surface exists above a shallow, slightly permeable barrier. A nonlinear, steady state, two-dimensional problem which is represented in a one-dimensional form was solved. The field problem considered is for flow in a shallow soil subject to uniform accretion and overlying a sloping bedrock. An integrating factor is used to solve the nonlinear equation subject to upper and lower boundary conditions of known hydraulic head or flow. An exact analytical solution is developed for steady flow in a sloping Dupuit aquifer. Constant areal accretion in the form of recharge from the surface and/or a leaky substratum occurs. The solution is useful for checking more comprehensive numerical treatments, and in the limit, those with time dependence. (Collier-IVI)
W85-05796

SENSITIVITY ANALYSIS FOR STEADY STATE GROUNDWATER FLOW USING ADJOINT OPERATORS,
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
J. F. Sykes, J. L. Wilson, and R. W. Andrews.
Water Resources Research. Vol. 21, No. 3, p 359-371, March, 1985. 12 Fig, 16 Ref.

Descriptors: *Groundwater movement, *Sensitivity theory, *Paradox Basin, *Leadville formation, *Utah, Groundwater recharge, Piezometric head, Computer models, Finite element theory, Boundary conditions, Hydraulic conductivity.

Adjoint sensitivity theory is currently being considered as a potential method for calculating the sensitivity of nuclear waste repository performance measures to the parameters of the system. For groundwater flow systems, performance measures of interest include piezometric heads in the vicinity of a waste site, velocities or travel time in aquifers, and mass discharge to biosphere points. The parameters include recharge-discharge rates, prescribed boundary heads or fluxes, formation thicknesses, and hydraulic conductivities. The derivative of a performance measure with respect to the system parameters is usually taken as a measure of sensitivity. To calculate sensitivities, adjoint sensitivity equations are formulated from the equations describing the primary problem. The solution of the primary problem and the adjoint sensitivity problem enables the determination of all of the required derivatives and hence related sensitivity coefficients. Adjoint sensitivity theory was developed for equations of two-demensional steady state flow in a confined aquifer. Both the primary flow equation and the adjoint sensitivity equation were solved using the Galerkin finite element method. The developed computer code was used to investigate the regional flow parameters of the Leadville Formation of the Paradox Basin in Utah. The results illustrate the sensitivity of calculated local heads to the boundary conditions. Alternatively, local velocity related performance measures are more sensitive to hydraulic conductivities. (Author's abstract)
W85-05799

PRESSURE BUILDUP ANALYSIS FOR TWO-PHASE GEOTHERMAL WELLS: APPLICATION TO THE BACA GEOTHERMAL FIELD,
S-Cubed, La Jolla, CA.
T. D. Riney, and S. K. Garg.
Water Resources Research, Vol. 21, No. 3, p 372-382, March, 1985. 16 Fig, 14 Ref. Lawrence Berkeley Laboratory contract 4514510.

Descriptors: *Baca geothermal field, *Redondo Creek, *New Mexico, *Geothermal power, *Wells, Injection wells, Permeability, Groundwater.

A geothermal system may be two-phase before production or may evolve into a two-phase system as a result of fluid production. Recently published pressure transient analysis methods for two-phase geothermal wells were employed to analyze the pressure buildup data for several wells located in the Redondo Creek area of the Baca geothermal field in New Mexico. There is a two-phase region initially present near the top of the Baca reservoir and all of the Baca wells induce flashing in the near-well bore formation during production. Nonproductive wells at Baca geothermal field have been used as injection wells. The ability of these wells to accept high injection rates implies that all permeable zones may not be productive zones. Zones at which fluid enters the well bore from the formation were located by interpretation of the downhole drilling information and pressure/temperature surveys and the initial reservoir temperature and pressure in these zones was estimated.

Interpretation of the buildup data for each well considered well bore effects (e.g., phase change in the well bore fluid and location of the pressure sensor with respect to the permeable horizon) and the carbon dioxide content of the the fluid and its effects on the phase behavior of the reservoir fluids and differentiated between the single- and two-phase portions of the pressure buildup data. Different straight-line approximations to the two portions (i.e., single- and two-phase) of the data on the Horner plot were used to obtain corresponding estimates for the single- and two-phase mobilities. A slope in the single phase portion of the Horner plot reflects the buildup behavior in the production zone and extends over two log cycles; it was used to estimate the formation permeability-thickness (kH) product. (Collier-IVI)
W85-05800

EVALUATION OF THE POLUBARINOVA-KOCHINA FORMULA FOR THE DAM PROBLEM,
Hochschule der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Fachbereich Informatik.
U. Hornung, and T. Krueger.
Water Resources Research, Vol. 21, No. 3, p 395-398, March, 1985. 5 Fig, 3 Tab, 12 Ref.

Descriptors: *Groundwater movement, *Numerical analysis, *Seepage, *Dams, Unconfined aquifers, Free boundaries, Mathematical analysis.

The stationary problem of unconfined groundwater flow through a rectangular dam has been solved by P. Ya. Polubarinova-Kochina (Theory of Ground Water Movement, Princeton University Press, Princeton, NJ, 1962). The analytical formulas presented by Polubarinova-Kochina were used to obtain accurate numerical values for the phreatic surface and for the height of the seepage face. Above an impervious layer, a homogeneous porous dam separates two lakes; the upper boundary of the domain filled with water is the phreatic surface which is the free boundary to be determined. These values provide a reference with which to compare numerical methods for seepage problems. (Collier-IVI)
W85-05803

CALCULATION OF SEEPAGE FROM A RESERVOIR BY THE MATHEMATICAL MODELING METHOD,
E. A. Khachatryan, G. T. Khachaturyan, and A. B. Bagdasaryan.
Hydrotechnical Construction, Vol. 18, No. 7, p 303-307, July, 1984. 4 Fig, 4 Ref. Translated from Gidrotekhnichkesoe Stroitel'stvo, No. 7, p 21-25, July, 1984.

Descriptors: *Seepage, *Reservoirs, *Mathematical models, *Akhuryan River, *USSR, Water loss, Model studies, Grout curtains, Geology.

The reservoir being created by constructing a 90 m high earth dam with a central loam core in a narrow canyon of the Akhuryan River is an integral part of the Akhuryan irrigation system. The seasonal storage reservoir is intended for irrigating 15,000 ha of newly developed lands and also for increasing the water supply of 20,000 ha of presently irrigated lands. A special feature of the geological structure of the soils in the region of the reservoir is the presence of an ancient buried channel of the Akhuryan River located on the river bank of the present channel. The permeability coefficients in the entire region both horizontaly and vertically vary within very wide limits. The permeable stratum of soils is inhomogeneous, and anisotropic. The curves of the seepage losses were determined as a function of the water level in the reservoir for different variants of the length of the grout curtain, by means of which the optimal length of the grout curtain can be determined by technicoeconomic calculations. Determination of the gradients and losses of water requires the establishment of the seepage field (head field) both within the reservoir and in the regions of the present valley and ancient channel of the Akhuryan River, which strongly affects the character of the seepage flow. Cutoff measures are needed in the foundation of the dam and it is irrational to extend the grout curtain along the right wall more than 1000 m, since with its farther continuation the seepage losses decrease negligibly. (Baker-IVI)
W85-05822

AQUIFER TEST ANALYSIS IN NONRADIAL FLOW REGIMES: A CASE STUDY,
Oak Ridge National Lab., TN.
E. D. Smith, and N. D. Vaughan.
Ground Water, Vol. 23, No. 2, p 167-175, March-April, 1985. 7 Fig, 2 Tab, 23 Ref. Office of Defense Waste and By-Product Management, DOE contract DE-AC05-840R21400.

Descriptors: *Aquifers, *Groundwater movement, *Nonradial flow, *Tennessee, *Conassauga Group, Drawdown, Pumping, Geologic fractures, Transmissivity, Storage, Geohydrology.

A low-rate aquifer pumping test was conducted in a folded and fractured limestone formation in the Conasauga Group of East Tennessee. An elongate drawdown pattern was observed, suggesting the pumping response was controlled by a highly conductive zone associated with a pair of anticlinal folds that bisect the test site. This drawdown pattern, the nonlinearity of graphs of observation well drawdown versus the log of time, and the existence of a linear relationship between drawdown and the square root of pumping time indicate that flow in response to pumping was nonradial. Thus, use of pumping test interpretive techniques based on radial flow models would be invalid. This situation may occur frequently when pumping tests are done in low-permeability media, because fractures and other discontinuities often dominate the hydraulic behavior of low-permeability media. The solution technique used to estimate aquifer parameters treats the fold axes as a highly conductive vertical fracture in an anisotropic matrix of much lower hydraulic conductivity. The complexity of both the site and the solution technique necessitated iterative trial-and-error variable substitution to estimate aquifer parameters. The resulting solution includes estimates of matrix transmissivity in two directions, the storage coefficient of the matrix, and the effective length and location of the major fracture. Estimates of hydraulic parameters reflect the apparent precision of values that would be generated by radial flow techniques, but they are consistent with geologic conditions at the site and present a clearer picture of the hydrogeologic regime than could be obtained with other investigative techniques. The solution technique used, whose field application has not been described previously in published literature, makes it possible to interpret the results of aquifer tests in complex hydrogeologic settings. This and related analytical techniques for other nonradial flow situations may prove useful in other hydrogeologic investigations in low-permeability media affected by folds, faults, fractures, or solution channels. (Author's abstract)
W85-05837

FAULT SEVERED AQUIFERS ALONG THE PERIMETERS OF WYOMING ARTESIAN BASINS,
Wyoming Univ., Laramie. Dept. of Geology and Geophysics.
P. W. Huntoon.
Ground Water, Vol. 23, No. 2, p 176-181, March-April, 1985. 4 Fig, 16 Ref.

Descriptors: *Geologic faults, *Aquifers, *Groundwater movement, *Wyoming, *Artesian basins, Geohydrology, Geologic formations.

The mountain uplifts which border the major artesian basins of Wyoming are asymmetric antiforms bounded on one flank by large displacement Laramide thrust faults. These thrusts sever the hydraulic continuity of aquifers, thereby creating separate circulation systems in the hanging wall and foot wall blocks. Fault severing of the Paleozoic aquifers can be identified by (1) potentiometric discontinuities across the faults, (2) water quality contrasts across the faults, and (3) geothermally heated waters in the foot wall blocks. Isolated but active circulation systems develop in the hanging wall blocks in which good permeabilities and good quality water prevail. In contrast the foot walls are generally characterized by poor permeabilities and poor water qualities. Fault severing of the Paleozoic aquifers in the Wyoming foreland province is a significant factor because nearly half of the basin perimeters are fault severed. The result is that exploration for large-volume, good-quality supplies must focus on the hanging wall blocks in the fault severed environments. (Author's abstract)
W85-05838

RELATIONS BETWEEN AQUIFER ELECTRICAL AND HYDRAULIC PROPERTIES,
Nebraska Univ.-Lincoln. Dept. of Civil Engineering.
W. E. Kelly, and R. K. Frohlich.
Ground Water, Vol. 23, No. 2, p 182-189, March-April, 1985. 10 Fig, 23 Ref. NSF grant ENG 7819408.

Descriptors: *Aquifers, *Electrical properties, *Hydraulic properties, *Rhode Island, Hydraulic conductivity, Geohydrology, Particle size, Soil types.

The primary factor controlling material-level relations between aquifer electrical and hydraulic properties in the clay-free aquifer materials of southern Rhode Island is an inverse relation between in-situ porosity and grain size. In-situ density, grain size and laboratory hydraulic conductivity data support this conclusion. Relations between either layer resistivities and hydraulic conductivity, or a Dar Zarrouk parameter and transmissivity, are influenced by aquifer layering and the position of the aquifer layer relative to nonproducing layers. In the study area, the best relations between electrical and hydraulic properties are obtained where the transverse resistance of the aquifer is measured. (Author's abstract)
W85-05839

POTENTIOMETRIC MAPPING FROM INCOMPLETE DRILL-STEM TEST DATA: PALO DURO BASIN AREA, TEXAS AND NEW MEXICO,
Stone and Webster Engineering Corp., Cherry Hill, NJ.
E. S. Bair, T. P. O'Donnell, and L. W. Picking.
Ground Water, Vol. 23, No. 2, p 198-211, March-April, 1985. 10 Fig, 30 Ref.

Descriptors: *Aquifer characteristics, *Potentiometric mapping, *Palo Duro Basin, *Texas, *New Mexico, *Groundwater potential, *Drill-stem tests, Wells, Geohydrology.

Drill-stem test (DST) data from wildcat wells and wells sponsored by the U.S. Department of Energy were used to construct pressure-depth diagrams and regional potentiometric surfaces of the Wolfcamp and Pennsylvanian aquifers. These deep-basin aquifers represent the two regionally important downgradient aquifers that underlie the host rock at the proposed high-level nuclear-waste repository sites in the Palo Duro Basin area of Texas and New Mexico. More than 5,500 DSTs were screened and classified according to shut-in pressure and shut-in time criteria devised to evaluate the quality of the DST data and to delete dubious DST data. After screening, three sets of pressure-depth diagrams and potentiometric-surface maps were constructed, corresponding to three levels of data refinement. The initial Wolfcamp and Pennsylvanian regional potentiometric surfaces contained several prominent local mounds and depressions with unrealistic variations in the direction and magnitude of hydraulic gradients. Pressure-depth data and records and maps of historic oil and gas production showed that many DSTs were performed in depressured oil and/or gas production zones. The low shut-in pressures recorded during these tests caused abnormally low heads to be calculated and contoured. Formation pressures recorded in these depressured zones represent local temporal pressures in a regional flow system that is probably steady state. Deletion of depressured DSTs produced regional potentiometric surfaces that were more realistic but contained a few large local mounds and depressions caused by local aberrant DST data. Deletion of local aberrant grossly

underpressured DSTs not attributable to oil and/or gas production and local aberrant grossly overpressured DSTs, based on comparison of initial shut-in pressures and heads in the same well and/or in adjacent wells at a similar depth in the same geologic unit, produced potentiometric surfaces that show regional and some local variations in flow directions and hydraulic gradients. Linear regression of the pressure-depth data showed that most of the refinement in the data was due to culling depressured DSTs. Some additional refinement was due to culling local aberrant grossly underpressured and grossly overpressured DSTs. (Author's abstract)
W85-05841

AQUIFER-PARAMETER EVALUATION FROM VARIABLE-RATE PUMPING TESTS USING CONVOLUTION AND SENSITIVITY ANALYSIS,
Kansas State Geological Survey, Lawrence.
M. A. Butt, and C. D. McElwee.
Ground Water, Vol. 23, No. 2, p 212-219, March-April, 1985. 2 Fig, 3 Tab, 31 Ref.

Descriptors: *Aquifers, *Pump testing, *Hydraulic properties, *Convolution, *Sensitivity analysis, Geohydrology, Mathematical analysis, Drawdown, Transmissivity, Storage coefficient.

The reliability of predictive and management models for ground water would be improved by better aquifer-parameter estimation. As progress continues in the use of computers to simulate ground-water systems, parallel progress must occur in data collection and analysis. Among the various methods available for the determination of aquifer parameters, pumping tests occupy a prominent position. The maximum advantage is gained from a pumping test when geological knowledge of the aquifer and the analysis of aquifer test data complement each other. A technique involving the use of convolution and sensitivity analysis was developed to obtain the 'best fit' of aquifer parameters in a least-squares sense from a pumping test with variable pumping rate. The method also can be used to analyze the residual drawdown data obtained during the recovery period. In addition, this method can also analyze drawdown and recovery data conjunctively. Constant drawdown and variable discharge data of artesian flowing wells also can be analyzed by this method. The method is straightforward, quick, inexpensive, and is always objective. No graphical plots or graphical interpretations are needed. As a measure of error, the rms (root-mean-square) error in drawdown is calculated along with correlation coefficient between pumping-test data and the theoretically generated data, using the converged values of transmissivity and storage coefficient. (Author's abstract)
W85-05842

COMPARISON OF METHODS FOR ESTIMATING GROUND-WATER PUMPAGE FOR IRRIGATION,
Geological Survey, Boise, ID. Water Resources Div.
S. A. Frenzel.
Ground Water, Vol. 23, No. 2, p 220-226, March-April, 1985. 1 Fig, 3 Tab, 13 Ref.

Descriptors: *Groundwater, *Pumpage, *Irrigation water, *Snake River Plain, *Idaho, Statistical analysis, Water management, Groundwater management, Instantaeous discharge.

Groundwater pumpage for irrigation was measured at 32 sites on the eastern Snake River Plain in southern Idaho during 1983. Pumpage at these sites also was estimated by three commonly used methods, and pumpage estimates were compared to measured values to determine the accuracy of each estimate. Statistical comparisons of estimated and metered pumpage using an F-test showed that only estimates made using the instantaneous discharge method were not significantly different (alpha = 0.01) from metered values. Pumpage estimates made using the power consumption method reflect variability in pumping efficiency among sites. Pumpage estimates made using the crop-consumptive use method reflect variability in water-management practices. Pumpage estimates made using the instantaneous discharge method reflect variability in discharges at each site during the irrigation season. (Author's abstract)
W85-05843

ANALYSIS OF STEADY-STATE FLOW IN SEMICONFINED AQUIFERS: A NEW APPROACH,
Physical Research Lab., Ahmedabad (India).
S. K. Gupta, and P. Sharma.
Ground Water, Vol. 23, No. 2, p 227-232, March-April, 1985. 3 Fig, 2 Tab, 7 Ref, 1 Append.

Descriptors: *Semiconfined aquifers, *Aquifers, *Groundwater movement, *Steady flow, *Mathematical analysis, Wells, Pumping tests, Hydraulic properties.

The well known methods of analyzing pumping tests in a semiconfined aquifer are of two types: based on steady-state conditions and based on unsteady-state conditions. Curve matching techniques and methods involving analysis of the straight line portion of the distance drawdown plot are either subjective or limited in usefulness. A new method for evaluation of aquifer parameters was developed utilizing a formula based on the following concept: In the case of semiconfined aquifers the ratio of steady-state drawdown to its gradient with respect to the logarithm of radial distance from the pumping well determines the transmissivity of the aquifer. As the method does not involve curve matching, it avoids subjectivity. The method is limited by errors introduced in estimation of some of the parameters outside of certain ranges. A straight-line method gives a reasonable estimate of transmissivity alone. (Collier-IVI)
W85-05844

COMPUTERIZED GROUND-WATER RESOURCES INFORMATION SYSTEM,
Michigan State Univ., East Lansing. Dept. of Geology.
G. W. Monaghan, and G. J. Larson.
Ground Water, Vol. 23, No. 2, p 233-239, March-April, 1985. 5 Fig, 10 Ref, 4 Append.

Descriptors: *Computerized data bases, *Groundwater management, *Geohydrology, *Hydrologic data collections, Computer models, Wells, Path of pollutants, Groundwater movement, Groundwater pollution, Water management.

A major restriction to the use of maps and cross sections of subsurface conditions is that they require a considerable investment in time and labor to construct and are often out of date soon after they are completed. To make geohydrologic information more readily available to those involved in groundwater investigations, a computerized retrieval system, called the Michigan Computerized Groundwater Resources Information Bank, was developed. The MCGRIB system is a computerized data base of hydrogeologic information consisting over 15,000 individual entries if which most are drillers' logs of water, oil, and gas wells drilled in Michigan since 1965. It also includes software that allows the user to display hydrogeologic data for any specified area in tabular or map form. The system provides a data base upon which sophisticated analog and digital models can be applied. In the event of accidental spills of toxic substances, the information included within the MCGRIB system could be used by local authorities to ascertain the vulnerabililty of nearby aquifers to contaminations and allow rapid assessment of contaminant movement. In addition to lithologic and hydrologic data, the MCGRIB system can easily be expanded to accept geochemical information about the ground water. Although the system is designed mainly for glaciated regions it can be adapted to almost any geologic setting. The main advantages of the system are that it can be updated regularly and can rapidly provide pertinent information about subsurface hydrogeologic conditions. (Collier-IVI)
W85-05845

COMPUTERIZED TECHNIQUE FOR ESTIMATING THE HYDRAULIC CONDUCTIVITY OF AQUIFERS FROM SPECIFIC CAPACITY DATA,
Wisconsin Geological and Natural History Survey, Madison.
K. R. Bradbury, and E. R. Rothschild.
Ground Water, Vol. 23, No. 2, p 240-246, March-April, 1985. 5 Fig, 2 Tab, 15 Ref, 2 Append. DOE contract DE-AC05-84OR21400.

Descriptors: *Data processing, *Permeability coefficient, *Aquifers, *Specific capacity, *Wisconsin, Pumping tests, Capacity, Computer models.

Specific capacity data obtained from well construction reports can provide useful estimates of hydraulic conductivity (K). A simple computer program has been developed which can correct specific capacity data for partial penetration and well loss and, using an iterative technique, provide rapid estimates of K at hundreds of data points. The program allows easy data handling and is easily linked with existing statistical programs or contour mapping routines. The method was tested at two field sites in Wisconsin, one underlain by a sandy outwash aquifer, the other by fractured dolomite. In both areas, estimates of K from corrected specific capacity data agree reasonably well with data from pumping tests. (Author's abstract)
W85-05846

GENERAL PURPOSE MICROCOMPUTER AQUIFER TEST EVALUATION TECHNIQUE,
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
C. J. Hemker.
Ground Water, Vol. 23, No. 2, p 247-253, March-April, 1985. 4 Fig, 17 Ref, 1 Append.

Descriptors: *Aquifers, *Data analysis, *Computer programs, *Pumping tests, Nonlinear regression, Mathematical analysis, Algorithms.

Although determination of aquifer characteristics from pumping test data is generally carried out using type curves or other graphical techniques, a number of computer methods have been developed recently for this purpose. Based on the principle of least squares, these methods of nonlinear regression can be applied to any flow system for which analytical expressions of the drawdown distribution are known. In view of the growing general interest in the application of microcomputers in groundwater hydrology, a BASIC routine has been developed for estimating any number of aquifer parameters. The least squares solution is calculated by Marquardt's algorithm, using the singular-value decomposition of the Jacobian matrix. The robust computing method obtained can be applied to all kinds of pumping tests. Aquifer characteristics as well as their standard deviations are computed with optimal speed and accuracy. The technique is demonstrated by a simple application to steady flow in a leaky aquifer and an example is provided. Other applications are easily implemented and programs for unsteady-state aquifer tests, recovery tests and multiple aquifer tests are available. (Author's abstract)
W85-05847

2G. Water In Soils

INFILTRATION INTO A CLASS OF VERTICALLY NON-UNIFORM SOILS,
Institute of Hydrology, Wallingford (England).
K. Beven.
Hydrological Sciences Journal, Vol. 29, No. 4, p 425-434, December, 1984. 4 Fig, 2 Tab, 19 Ref.

Descriptors: *Infiltration, *Soil water, *Soil profiles, Soil types, Soil horizons, Permeability coefficient, Model studies, Rainfall rates.

Traditionally, non-uniformities with depth have been classified with respect to layers of the soil. In the analysis of flow through soils that are non-uniform with depth, it is often assumed that soil hydraulic properties are more homogeneous within horizons or layers than between layers. A more

continuous approach to changes in hydraulic characteristics with depth may be more appropriate in some soils, particularly in the case of near surface properties affecting infiltration. An infiltration model based on the Green-Ampt assumptions was developed for a class of non-uniform soils in which saturated hydraulic conductivity decreases as an exponential function of depth, and the storage-suction factor is a constant. Assumptions about soil hydraulic characteristics implicit in the model are that saturated hydraulic conductivity should be adequately described by a functional relationship and the product of potential difference at the wetting front and the difference in the moistures content across the wetting front should be constant with depth. An analysis of measured hydraulic conductivity and porosity data suggests that the model may be useful in some soils where the changes of hydraulic characteristics with depth are of this form. A method for using the model with time variable rainfall rates is given. The model was applied to simulate the experimental measurements of infiltration into layered sand profiles. Agreement was satisfactory even for this case. (Collier-IVI)
W85-05006

AGRICULTURAL WATER POLLUTION CONTROL: AN INTERDISCIPLINARY APPROACH,
Max C. Fleischmann Coll. of Agriculture, Reno, NV.
For primary bibliographic entry see Field 6B.
W85-05067

EVALUATION OF AGRICULTURAL DROUGHT USING PRORABILITY DISTRIBUTION OF SOIL MOISTURE INDEX,
Indian Agricultural Research Inst., New Delhi. Div. of Agricultural Physics.
For primary bibliographic entry see Field 2B.
W85-05075

LEACHING OF SOLUBLE SALT DURING INFILTRATION AND REDISTRIBUTION,
Hanover Univ. (Germany, F.R.). Inst. fuer Bodenkunde.
I. S. Dahiya, M. Singh, J. Richter, and M. Singh.
Irrigation Science, Vol. 5, No. 1, p 15-24, April, 1984. 5 Fig, 2 Tab, 27 Ref.

Descriptors: *Leaching, *Salts, *Infiltration, *Redistribution, *Soil water, Soil types, Sandy soils, Loam soils, Clay soils.

Miscible displacement of soluble salts during infiltration and redistribution of water was studied experimentally in vertical, homogeneous columns of sandy, sandy loam and clay soils with initially uniform salt and moisture contents. Calcium chloride, mixed uniformly in initially dry and moist soils, was leached with water under transient and steady infiltration conditions. The salt and water profiles were determined immediately following infiltration and after matching total infiltration and redistribution times. Irrespective of different flow conditions and soil types, the 'centre of mass' of salt front coincided with the 'piston front' that would exist given perfect displacement of water initally present in the soil by the water being infiltrated (piston-flow model). Furthermore the advance of 'center of mass' of salt front was independent of the water application rate and initial soil water content in all soils following both infiltration and redistribution. (Author's abstract)
W85-05163

APPLICATION OF THE POTENTIAL CONCEPT TO SOIL WATER EQUILIBRIUM AND TRANSPORT,
Colorado Agricultural Experiment Station, Fort Collins.
A. T. Corey, and A. Klute.
Soil Science Society of America Journal, Vol. 49, No. 10, p 3-11, January/February, 1985. 1 Fig, 43 Ref.

Descriptors: *Soil water potential, *Water transport, Soil properties, Water potentials, Thermodynamics.

The view that a total soil water potential can be defined such that the water component will always move from regions of higher to regions of lower potential and, that if the total potential is constant at all points, the water component is in equilibrium is examined. Transport of water component in a soil solution occurs by two mechanisms: convection of the solution or gas phase in which the water exists, and diffusion of the component water relative to the bulk motion of the phase. The major shortcoming is a failure to distinguish between components of a potential that apply only to elements of the soil solution and those that apply only to the water component. Concepts from texts dealing with transport processes and thermodynamics show that there is no single potential that is a function of the state of the soil solution only, whose gradient will always indicate the direction of net transport of the water component, or which, if constant in all parts of the system, will ensure that equilibrium exists. (Baker-IVI)
W85-05178

EVALUATION OF CLOSED-FORM ANALYTICAL MODELS TO CALCULATE CONDUCTIVITY IN A FINE SAND,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
D. B. Stephens, and K. R. Rehfeldt.
Soil Science and Society of American Journal, Vol. 49, No. 1, p 12-19, January-February, 1985. 6 Fig, 3 Tab, 21 Ref. Bureau of Mines grant GI1151132 UNIV NEV.

Descriptors: *Soil properties, *Sand, *Permeability coefficient, Soil water, Model studies, Computer models.

The soil water characteristic curve was determined for an undisturbed core of fine sand over a range of negative pressure heads observed in the field, 0 to 150 cm, below about the 30 cm depth. These data were used to predict relative hydraulic conductivity in a computer code of closed-form analytical solutions developed by van Genuchten for the theoretical models of Burdine and Mualem. Van Genuchten's approach is versatile, convenient and sufficiently accurate for practical purposes. However, the reliability of the method may depend on physically reasonable estimates of various parameters and an adequate data base. (Baker-IVI)
W85-05179

MEASUREMENT OF SOIL WATER CONTENT USING TIME-DOMAIN REFLECTROMETRY (TDR): A FIELD EVALUATION,
Department of Agriculture, Ottawa (Ontario). Land Resource Research Inst.
G. C. Topp, and J. L. Davis.
Soil Science Society of American Journal, Vol. 49, No. 1, p 19-24, January/February, 1985. 8 Fig, 3 Tab, 8 Ref.

Descriptors: *Soil water, *Measuring instruments, *Time-domain reflectrometry, Gravimetric sampling, Sampling.

Field evaluation of time-domain reflectrometry (TDR) for the measurement of soil water content was conducted under a crop of silage corn where measurements were taken from seeding time to harvest. Parallel pair transmission lines varying in length from 0.125 to 1 m were installed vertically at three sites; at one site horizontal lines and additional vertical transmission lines with electrical impedance discontinuities were installed for comparison. TDR measured water contents are compared to values obtained by gravimetric sampling. The study demonstrates that with a battery-powered instrument, the TDR technique is an accurate method for measuring soil water content in the field. The accuracy found was comparable to that of gravimetric samples. In both cases, the limit of accuracy appeared dependent upon the variability of the soil. When both methods used the same soil, standard deviation of differences were as low as 0.02 cu m/cu m. When TDR and gravimetric samples measured noncoincident samples, the standard deviation increased to 0.06 cu m/cu m. Both horizontally and vertically installed lines gave satisfactory measurements of water content. The horizontally installed lines, measuring over a larger horizontal cross-sectional, area showed less variation than vertical lines. The variety of transmission line configurations which have been evaluated provide considerable flexibility in choice of transmission lines to yield the desired water content information. (Baker-IVI)
W85-05180

GENERALIZED SOLUTION TO INFILTRATION,
Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.
A. W. Warrick, D. O. Lomen, and S. R. Yates.
Soil Science Society of America Journal, Vol. 49, No. 1, p 34-38, January/February, 1985. 3 Fig, 4 Tab, 21 Ref. OWRT project B-097-ARIZ.

Descriptors: *Infiltration, *Permeability coefficient, *Soil water, Mathematical equations, Richards' equation.

A generalized solution to the Richards moisture flow equation is developed for infiltration. The equation is expressed in terms of dimensionless time, depth, and water content. The reduced form applies for the hydraulic functions of van Genuchten or of Brooks and Corey as well as to other scaled forms and the solution utilizes the procedure of Philip. While the approach could be used for methods of solution other than that of Philip, his algebraic forms are particularly easy to apply and therefore were used. Possibly, the same approach could also prove useful for describing redistribution or cyclic water inputs even though the associated numerical calculations would, by necessity, be nonanalytical. In field situations where only scant information is available, textural classes may be used to estimate infiltration and wetting depths. If a great deal is known regarding soil properties, the results may be applied to systematically describe heterogeneity. For application, specifically measured hydraulic conductivities can be best-fitted to the forms used here or generalized empirical values can be used from the literature. (Baker-IVI)
W85-05182

EFFECT OF CATION EXCHANGE ON CALCULATED HYDRODYNAMIC DISPERSION COEFFICIENTS,
Guelph Univ. (Ontario). Dept. of Land Resource Science.
M. J. L. Robin, and D. E. Elrick.
Soil Science Society of America Journal, Vol. 49, No. 1, p 39-45, January-February, 1985. 7 Fig, 2 Tab, 12 Ref.

Descriptors: *Cation exchange, *Soil properties, *Dispersion, Hydrodynamics, Unsaturated flow, Chlorides, Potassium, Chemical reactions, Adsorption isotherms, Soil water.

Cation exchange is one of the most common reactions involving cations in soils. Although the reaction involves at least two cations, it is often described in transport equations by adsorption isotherms, which describe the behavior of a single cation associated with the solid phase as a function of its concentration in the liquid phase. The results of cation-exchange isotherm measurements made on an air-dry, salt-free, Ca-saturated Brookston silty clay loam are reported and the effect of a cation exchange reaction term on the calculated dispersion coefficient is presented. The cation exchange experiments demonstrated that the cation exchange data agreed very well with Laryea's adsorption isotherm. It was also noted that, although the exchange isotherms indicated a possible failure to reach equilibrium it was still possible to calculate very good fits of the isotherms at the experimental negative-change concentrations. The dispersion coefficient values obtained for Cl(-) and K(+) are about one order of magnitude higher than expected. This cannot be explained by the choice of the reaction term and may be due to the presence of immobile water and/or to anion exclusion. (Baker-IVI)
W85-05183

STATISTICAL RELATIONSHIP BETWEEN APPARENT DIELECTRIC CONSTANT AND WATER CONTENT IN POROUS MEDIA,
Universite Catholique de Louvain, Louvain-la-Neuve (Belgium). Unit of Management and Water Resources.
M. Ansoult, L. W. De Backer, and M. Declercq.
Soil Science Society of America Journal, Vol. 48, No. 1, p 47-50, January-February, 1985. 3 Fig, 16 Ref.

Descriptors: *Porous media, *Statistical models, *Soil water, *Dielectric constant, Electrical properties, Moisture, Soil properties.

Soil could be considered in a physical sense as a three-component mixture of air, solid, and water. Generally, the dielectric constant of air equals 1, that of solids equals 4, and that of pure water equals 80. The apparent dielectric constant of a soil, is greatly influenced by the volumetric mater content. A theoretical relationship between the apparent dielectric constant and the water content of porous media is presented. The dielectric effect of the porous medium is investigated at the microscopic scale of the probable path of an electric charge. The proposed model simulates well the experimental relationship in soils for degrees of freedom varying between 6 and 8. (Baker-IVI)
W85-05184

EFFECT OF TEMPERATURE-DEPENDENT HYDRAULIC PROPERTIES ON SOIL WATER MOVEMENT,
Alabama Agricultural Experiment Station, Auburn.
J. W. Hopmans, and J. H. Dane.
Soil Science Society of America Journal, Vol. 49, No. 1, p 51-58, January-February, 1985. 11 Fig, 22 Ref, 1 Append.

Descriptors: *Soil water, *Temperature effects, *Soil hydraulic properties, Boundary conditions, Soil properties, Head, Soil surface, Permeability coefficient.

Soil water movement was simulated under different temperature regimes for a variety of initial and boundary conditions. Corrections of soil hydraulic properties due to temperature changes were either based on experimental data extracted from the literature or on theoretical considerations. In the latter case, multiples of the calculated temperature coefficient of surface tension of water, which affect soil water pressure head, were also used to more nearly approximate experimentally determined values of dh/dT (the change of pressure head with temperature). The effect of temperature on water movement was found to depend on the type of boundary conditions, especially one at the soil surface where changes were most drastic, and on the kind of temperature regime superimposed on it. Temperature effects were much more pronounced for a pressure head than for a flux boundary condition at the soil surface. For temperature varying with both time and depth, the effects of temperature seemed to be minimal if the hydraulic properties were determined at the mean temperature of the profile. The latter suggests that those soil hydraulic properties which are determined in the lab for application to field condition should probably be determined at a temperature that is near the mean soil temperature under field conditions. The results also showed that temperature effects on soil water movement become more pronounced as the temperature coefficient of soil water pressure head increases and the kind of effect depends on whether the existing temperature is above or below the reference temperature. (Baker-IVI)
W85-05185

WATER RELATIONS OF SATURATED BENTONITE: SOME EFFECTS OF TEMPERATURE AND SOLUTION SALT CONCENTRATION,
Commonwealth Scientific and Industrial Research Organization, Adelaide (Australia). Div. of Soils.
D. E. Smiles, C. J. Barnes, and W. R. Gardner.
Soil Science Society of America Journal, Vol. 49, No. 1, p 66-69, January-February, 1985. 3 Fig, 1 Tab, 11 Ref.

Descriptors: *Soil water, *Bentonite, *Temperature effects, *Salinity, Saturated flow, Viscosity, Clay, Unsaturated soils, Air-water interface.

Attention is drawn to data that provide additional insights into some aspects of the temperature dependence of clay/water interaction, as well as indicating some useful empirical relations in clay systems. Transient flow and equilibrium pressure membrane experiments were used to determine some water relations of bentonite pastes in the range of water content from 6 to 33. The pastes were prepared in equilibrium with three different sodium chloride concentrations and the experiments were performed at temperatures of 277, 293, and 306 K. For each solution salt concentration the moisture characteristic was effectively temperature independent, and the effect of solution concentration was qualitatively, but not quantitatively, in agreement with electrical double layer theory. Both the cumulative outflow and the water content profiles in the transient flow experiments revealed clear temperature dependence. This effect was accounted for by the temperature dependence of the kinematic viscosity of water. Apparently temperature dependence, over and above effects on viscosity, in the moisture characteristics and flow properties in unsaturated soils arises not in double-layer effects, but in effects on the air water interfaces in these systems. (Baker-IVI)
W85-05186

TEMPORAL RESPONSE OF SOIL DENITRIFICATION RATES TO RAINFALL AND IRRIGATION,
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
A. J. Sexstone, T. B. Parkin, and J. M. Tiedje.
Soil Science Society of America Journal, Vol. 49, No. 1, p 99-103, January-February, 1985. 6 Fig, 2 Tab, 19 Ref. NSF grant DEB-80-12168.

Descriptors: *Denitrification, *Soil chemistry, *Rainfall, *Irrigation effects, Temporal distribution, Soil water, Porosity, Nitrogen loss, Anaerobic conditions, Microsites, Sampling.

The short-term response of field denitrification rates to rainfall and irrigation is reported. Peak denitrification rates usually occurred for brief periods after a moisture addition, but the response time and duration were different for light and heavy textured soil. A maximum denitrification rate was generally observed following both natural and laboratory wetting events. This increased rate did not occur until after a characteristic lag time which depended on soil texture. A major effect of increased soil moisture is thought to be a decreased rate of oxygen supply leading to the establishement of anaerobic zones of microsites where denitrification can occur. The sandy loam soil used in this study is non-aggregated and does not hold water readily, while the clay loam soil had good structure and holds much more water at any given moisture potential. When the soil was relatively dry, rate estimates could be extrapolated over a 2 to 3 day period provided that a sufficient number of cores were evaluated. The denitrification rate in the sandy loam soil increased immediately after water addition and reached a maximum rate within 3-5 hr and returned to preirrigation levels within 12 hr. A similar, but slower denitrification response occurred in the clay loam soil, requiring 8-12 hr before a maximum rate was observed and 48 hr before the original background rate was restored. Significant denitrification losses can occur in bursts in response to rainfall, and sampling schemes based on integration of denitrification rate measurements must include these episodes to obtain meaningful estimates of N loss. A denitrification response to rainfall was not always the case, however, suggesting that NO3(-) or carbon may also limit nitrogen loss. (Baker-IVI)
W85-05187

EFFECT OF RAINDROP IMPACT ENERGY AND WATER SALINITY ON INFILTRATION RATES OF SODIC SOILS,
Agricultural Research Organization, Bet-Dagan (Israel).
M. Agassi, J. Morin, and I. Shainberg.
Soil Science of America Journal, Vol. 49, No. 1, p 186-190, January-February, 1985. 5 Fig, 2 Tab, 16 Ref.

Descriptors: *Soil water, *Infiltration, *Rain, *Salinity, *Sodic soils, Rainfall infiltration, Runoff, Dispersion, Electrolytes, Drop impact, Kinetic energy, Soil aggregates.

It is hypothesized that the infiltration rate of soils exposed to rain with no energy could be predicted from studies of the effect of soil sodicity and electrolyte concentration on hydraulic conductivity of soils. Conversely, when high energy rain is applied, the mechanical impact of the water drops will increase the susceptibiiy of the soil surface to both the soil exchangeable sodium percentage (ESP) and the electrolyte concentration in the applied water. Two soils were used for the study: a Calcic Haploxeralf (loess) from a site where annual precipitation is 400 mm, and a Typic Chromoxerert (vertisol) from a site where annual precipitation is 500 mm. Three levels of exchangeable sodium were taken for each soil. Rain was applied at two energy levels: high energy rain with kinetic energy of 22.9 J/mm sq m and a low energy rain with kinetic energy less than 0.01 J/mm sq m. Both the water drop impact energy and the electrolyte concentration in the applied rain have a decisive effect on the infiltration rate drop of soils. When the chemical dispersion processes are minimal the mechanical impact of the drops predominate and the crust formation is mainly due to the disintegration of the soil aggregates and their compaction to a thin skin seal. When the soil ESP is high, > 2.5, and the water salinity is low, rain water, chemical dispersion processes have an increasing role in determining the infiltration rate of the soils. (Baker-IVI)
W85-05188

EFFECT OF WATER QUALITY AND DRYING ON SOIL CRUST PROPERTIES,
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
M. Ben-Hur, I. Shainberg, R. Keren, and M. Gal.
Soil Science Society of America Journal, Vol. 49, No. 1, p 191-196, January-February, 1985. 5 Fig, 3 Tab, 14 Ref.

Descriptors: *Soil crusts, *Water quality, *Drying, Infiltration, Irrigation, Runoff, Rain, Arid regions, Salinity, Dispersion, Soil surface.

The presence of a crusted soil surface due to rainfall is a common feature of many soils, particualrly in the arid and semi-arid regions. The effect of drying of the crusted soil on the stability of the crust and its properties is examined. Drying the soil crust causes an increase in the crust permeability. This increase is due to the formation of cracks and the new structure at the soil surface. Both processes intensify as the crust dries. Whereas the wet crust is stable and maintains the original properties of the crust (low infiltration rate and the crust being almost independent of the salinity of the water in the subsequent storm). The structure of the crust upon drying changes and both crust permeability and crust's response to the salinity of the solution increase. The formation of a new and less cohesive structure at the soil surface upon drying increases the permeability of the crust and causes it to be more sensitive to the destructive effect introduced by the impact of the raindrops. (Baker-IVI)
W85-05189

GEOLOGY AND SOILS OF THE RHODE RIVER WATERSHED,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
J. W. Pierce.
In: Environmental Data Summary for the Rhode River Ecosystem (1970-1978), Section A: Long Term Physical/Chemical Data, Part 1: Airshed and Watershed, 1982. p 181-216, 7 Tab, 7 Ref, 3 Append.

Descriptors: *Watersheds, *Soil profiles, *Maryland, *Geological surveys, *Mineralogy, *Geolog-

ic formations, *Soil texture, Minerals, *Soil types, Rhode River Watershed, Montmorillonite, Kaolinite, Illite, Sand, Quartz, Clays, Alluvium, Baseline studies.

Data from three different projects were compiled to study the geology and solids of the Rhode River Watershed. The NSF-RANN and Smithsonian funded project sought to provide data on the type of minerals present in the silt and clay fractions of the soils and to see if any differences existed from watershed to watershed. The Forest Ecology Study analyzed soil textures and minerals. An EPA-funded study provided detailed mapping of the soils in the field-sized watersheds allowing determination of the solids present at each sampling site. Seven geologic fromations crop out in the Rhode River watershed. From these formations fifteen different soil series have developed. The stream valleys and a considerable portion of the shoreline of the Rhode River are covered with recent alluvial deposits. Sand constituted slightly over 40% of the soil followed by clay and silt. The soils of the single-use watersheds and the streams contained more sand and silt while the samples from tidal Muddy Creek had more silt and clay. The average mineralogy of the samples scattered over the entire watershed has considerably more montmorillonite than the average for the field sized watersheds. The variations in mineralogy may be due, in part, to textural differences. Quartz is the most common mineral in the soils followed by montmorillonite, illite, and kaolinite. Samples from the banks of Muddy Creek indicate a possible further fractionation during transport.
W85-05356

SEASONAL AND ANNUAL VARIATION IN THE TEMPERATURE AND MOISTURE CONTENT OF SOLIDS ON THREE SINGLE LAND-USE RHODE RIVER WATERSHEDS,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
D. L. Correll.
In: Environmental Data Summary for the Rhode River Ecosytem (1970-1978). Section A: Long Term Physical/Chemical Data, Part 1: Airshed and Watershed, 1982. p 217-259, 2 Fig, 5 Tab, 1 Ref.

Descriptors: *Watersheds, *Data collections, *Maryland, *Forest watersheds, *Agricultural watersheds, *Soil moisture retention, *Soil surveys, *Soil temperature, *Air temperature, *Seasonal variation, Baseline studies, Soil properties, Annual distribution, Elevation, Soil water.

Three small watershed basins representative of cropland, forest and pasturelands were studied from 1976 through 1979 with soil moisture and temperature probes buried at depths of 5, 15, 30, and 75 cm. In situ gravimetric moisture determinations were made by coring for comparison with gypsum block probe readings. Analysis of temperature data showed that significant vertical gradients were often found at all sites and that differences were apparent between land uses. However, within a given land use and at the same soil depth variations between elevational contours were usually not significant. Data for mean air temperature and soils at 5 and 75 cm depths show some differences in response for the three land use areas. Surface soils reached the highest temperature in pastureland and had the lowest temperature in cropland. Forest surface soils displayed the least temperature fluctuation. In laboratory studies, more variation in soil moisture retention was found in cropland soils. Field data on soil moisture retension for the three basins are summarized by month, elevational contour, and by soil depth. High soil moisture tensions occurred in summer and fall, typically peaking in September or October. Soil moisture tensions typically were lower at the pastureland site. At all sites tensions were very low from December through May, except at 5 cm depth.
W85-05357

ANALYTICAL SOLUTION TO THE PROBLEM OF SEEPAGE INTO COUNTERFORT DRAINS,
Kingston Polytechnic, Kingston upon Thames (England). School of Civil Engineering.
E. N. Bromhead.
Canadian Geotechnical Journal, Vol. 21, No. 4, p 657-662, November, 1984. 4 Fig, 6 Ref.

Descriptors: *Drainage, *Water seepage, *Trenches, *Counterfort drains, Permeability, Soil water, Mathematical studies, Slope stabilization.

The earliest treatment of the seepage of water to trench drains may have been that of Richardson (Richardson, L.F. 1908. Scientific Proceedings of the Royal Dublin Society, Vol. 11, No. 27, p 295-316). An analytical solution to the problem that defeated Richardson is presented. This solution assumes that the trench drains penetrate all the way through a soil layer of finite thickness and uniform permeability to an impermeable basal layer. The sides of the drains are wetted, and are at atmospheric pressure, which is the datum for all pressure measurements, but the drains operate with a negligible head of water in them. Details are presented on the design and peformance of trench and counterfort drains. Agreement between the analytical and numerical solutions is good, with the numerical approach proving to be much more economic in terms of computer resources. The results have been expressed in a form suitable for use in counterfort drain installations for slope stabilization. (Baker-IVI)
W85-05528

EXPLORATION OF A RIGID ICE MODEL OF FROST HEAVE,
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 2C.
W85-05791

HILLSIDE SEEPAGE: AN ANALYTICAL SOLUTION TO A NONLINEAR DUPUIT-FORCHHEIMER PROBLEM,
Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.
For primary bibliographic entry see Field 2F.
W85-05796

FINITE ELEMENT MATRIX AND MASS BALANCE COMPUTATIONAL SCHEMES FOR TRANSPORT IN VARIABLY SATURATED POROUS MEDIA,
GeoTrans, Inc., Herndon, VA.
For primary bibliographic entry see Field 5B.
W85-05798

STABILITY OF THE GREEN-AMPT PROFILE IN A DELTA FUNCTION SOIL,
Princeton Univ., NJ. Dept. of Civil Engineering.
P. C. D. Milly.
Water Resources Research, Vol. 21, No. 3, p 399-402, March, 1985. 2 Fig, 15 Ref.

Descriptors: *Soil water, *Green-Ampt profile, *Richards equation, *Delta function, Permeability coefficient, Mathematical analysis.

The sharp wetting front of Green and Ampt represents a solution of the Richards equation for infiltration into a delta-function soil. Delta-function diffusivity is not a sufficient condition for the existence of a stable Green-Ampt profile. In order that the sharpness of this profile be maintained in the presence of a small perturbation of the profile shape, it is sufficient that the second derivative of hydraulic conductivity with respect to moisture content be positive for all values of moisture content. An inspection of theoretical and experimental data on the hydraulic conductivity suggests that this condition is usually satisfied. The profile is also stable if the first derivative of hydraulic conductivity with respect to moisture content is proportional to a delta function. Soils that are the closest to having a Green-Ampt profile as a solution of the Richards equation are also the ones in which such a profile is least likely to be stable. (Collier-IVI)
W85-05804

2H. Lakes

WATER QUALITY CHARACTERISTICS OF THE HARIMA NADA COASTAL AREA, COD LOAD CAUSED BY PRIMARY PRODUCTION,
Hyogo Prefecture Environmental Science Inst., Kobe (Japan).
For primary bibliographic entry see Field 2L.
W85-04969

ELECTROCHEMICAL DETERMINATION AND CHARACTERIZATION OF SURFACE ACTIVE SUBSTANCES IN FRESHWATERS,
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.
B. Cosovic, V. Vojvodic, and T. Plese.
Water Research, Vol. 19, No. 2, p 175-183, 1985. 11 Fig, 2 Tab, 20 Ref. NBS grant NBS/IG-191/JF.

Descriptors: *Surfactants, *Humic acids, *Drinking water, *River water, *Groundwater, *Electrochemistry, *Chemical analysis, Polarography, Detergents.

Surface active material has been analyzed in samples of different freshwater systems: river water, groundwater and tap water, by electrochemical methods based on the measurement of the adsorption effects at the mercury electrode. Two electrochemical methods were used: the measurement of the suppression of the polarographic maxima and a.c. polarography. A rough characterization of predominant surface active compounds was performed through a comparison of the shape and the intensity of the electrochemical responses with those obtained with different model surfactants. It was found that humic substances represent predominant surface active substances in freshwater systems. The total surfactant activity corresponds to approx. 0.5-20 mg/cu dm of humic substances. Anionic detergents were analyzed by the spectrophotometric methylene blue method. The highest values (100-300 micro g/cu dm) were found in river water samples which were taken downstream from the city location. The total surfactant activity values of river water samples as measured by the electrochemical methods were only exceptionally influenced by the presence of detergents. (Author's abstract)
W85-04972

INORGANIC CARBON LIMITED GROWTH KINETICS OF SOME FRESHWATER ALGAE,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
J. T. Novak, and D. E. Brune.
Water Research, Vol. 19, No. 2, p 215-225, 1985. 15 Fig, 2 Tab, 23 Ref, 1 Append.

Descriptors: *Inorganic carbon, *Growth kinetics, *Algae, *Limiting nutrients, Light intensity, Water temperature, Competition, Species composition, Cyanophyta, Chlorophyta, Anabaena, Chlorella, Selenastrum, Scenedesmus, Oscillatoria, Microcoleus.

The inorganic carbon limited growth kinetics were determined for three green and three blue-green algae over a range of light and temperatures. Anabaena flos aquae was found to be the only algae to grow at 39 C. Selenastrum capricornutum and Scenedesmus quadricauda were favored at low temperatures with Selenastrum growing best at high light and carbon levels while Scenedesmus was the most rapidly growing algae under low light, carbon and temperature conditions. Chlorella was the fastest growing algae at temperatures from 27 to 33 C under all light and inorganic carbon concentrations. Neither Oscillatoria nor Microcoleus were found to be the dominant algae under the conditions tested. However, under reduced light and temperature conditions, Oscillatoria grew well at high inorganic carbon concentrations. (Author's abstract)
W85-04977

AVAILABILITY OF DISSOLVED IRON FROM TJEUKEMEER, THE NETHERLANDS, FOR

IRON-LIMITED GROWING SCENEDESMUS QUADRICAUDA,
Limnologisch Inst., Oosterzee (Netherlands). Tjeukemeer Lab.
H. De Haan, M. J. W. Veldhuis, and J. R. Moed.
Water Research, Vol. 19, No. 2, p 235-239, 1985. 4 Fig, 3 Tab, 19 Ref.

Descriptors: *Iron, *Lake Tjeukemeer, *Netherlands, *Scendesmus, *Limiting nutrients, *Algae, Chlorophyta, Lakes, Nutrients, Algal growth, Particulate matter, Colloids.

Tjeukemeer is a shallow, humic, alkaline and eutrophic lake in The Netherlands. Concentration of dissolved Fe(III)-ions is very low in summer and does not exceed 10 to the -23 power M. Iron uptake rates in Tjheukemeer may depend on the rates of dissolution of colloidal and particulate Fe(OH)3 and on photodegradation of naturally occurring Fe-complexes. If these rates are slow relative to those of Fe uptake, the growth rate of some phytoplankton species may decrease. In such a case Fe availability rather than Fe depletion would limit algal growth rates. Ultrafiltration of water from Tjeukemeer revealed that most dissolved Fe (< 0.2 micro m) is found in colloids between 350 and 2000 A. All dissolved Fe from NH4Fe(SO4)2.12H2O in the growth medium occurred in particles < 350 A, half of which did not exceed 100 A. The half-saturation growth constant (K sub s) of Fe-limited growth of Scenedesmus quadricauda in the presence of EDTA at pH 8.0 and using the natural Fe colloids was almost 3 times that using NH4Fe(SO4)2.12H2O. The maximum growth rate (mu max) was not affected by the particle size of the limiting Fe substrate. Fe from the natural colloids is approximately one-third as much available as from NH4Fe(SO4)2.12H2O. Explainations of algal succession by resource competition as derived from K sub s values using artificial media, do not reflect the natural form and availability of the growth limiting nutrients involved. The chemostat is a helpful tool to investigate the role of these physico-chemical factors in phytoplankton ecology. (Collier-IVI)
W85-04978

ALGAL CONTROL OF LAKE GEOCHEMISTRY; REDOX CYCLES IN ROSTHERNE MERE, U.K.,
Freshwater Biological Association, Ambleside (England).
W. Davison, C. S. Reynolds, and B. J. Finlay.
Water Research, Vol. 19, No. 2, p 265-267, 1985. 1 Fig, 1 Tab, 21 Ref.

Descriptors: *Rostherne Mere, *United Kingdom, *Redox cycles, *Algae, *Geochemistry, *Lakes, *Sediment-water interface, *Bottom water, Phytoplankton, Hypolimnion, Iron, Sulfate, Sulfur, Carbon, Anoxic conditions, Methanogenesis, Oxidation.

The chemistry of the bottom waters of a lake may depend upon the particular algal species dominating the phytoplankton. Apparently some some common algal species whose life cycles include a dormant stage at the sediment surface can have a significant influence on the chemistry of the overlying hypolimnion. Most notably iron and sulfate are bypassed as electron sinks in favor of carbon which will serve as a substrate for methanogenesis. The suprising absence of the reduced forms of iron and sulfur from the anoxic hypolimnion of biologically productive Rostherne Mere is attributed to carbon decomposition processes occurring within the sediment rather than at its interface. The dominant phytoplankton (Microcystis or Ceratium) sink, and initially remain viable as a layer on the sediment surface. Oxidation of carbon occurs deeper within the sediment and is isolated from the water column. Carbon probably acts as the electron acceptor (methanogenesis) because the supply and removal of inorganic redox couples is limited by molecular diffusion. As a consequence of the particular biological features of the lake and of its dominant phytoplankton species, organic decomposition and consequent electron transfer is displaced from the hypolimnion and sediment-water interface to deeper sediments. The sediment-water interface is effectively replaced by a physical barrier of sedimenting algae resisting decomposition. This barrier separates the different redox processes of bottom water and deep sediment. Iron and sulfur are simply bypassed as electron sinks in favor of carbon itself in the form of mobile methane. (Collier-IVI)
W85-04982

MICROCALORIMETRIC APPROACH TO DETERMINE RELATIONSHIPS BETWEEN ENERGY SUPPLY AND METABOLISM IN RIVER EPILITHON,
University Coll. of North Wales, Bangor. School of Animal Biology.
M. A. Lock, and T. E. Ford.
Applied and Environmental Microbiology, Vol. 49, No. 2, p 408-412, February, 1985. 5 Fig, 15 Ref. Natural Environment Research Council (United Kingdom) grant GR3/4295 A.

Descriptors: *Epilithon, *Metabolism, *Microorganisms, Organic matter, Bacterial physiology.

In a study to determine the relative importance of various apparent molecular weight fractions to the metabolism (heat output) of attached microorganisms in rivers, a marked lack of response to gross changes in the external organic matter supply was noted over the course of several hours. Such a response by a mixed autotrophic-heterotrophic community could be attributed to the autotrophs being the sole organic energy source for the heterotrophs. However, substantial metabolic activities were noted in attached microbial communities grown in darkness (algae free), thus indicating that riverborne organic matter was a major energy source. This paradox was attributed to a proposed lag in the availability of dissolved and colloidal organic matter to the heterotrophic microorganisms. (Author's abstract)
W85-05052

KINETIC STUDIES OF BACTERIAL SULFATE REDUCTION IN FRESHWATER SEDIMENTS BY HIGH-PRESSURE LIQUID CHROMATOGRAPHY AND MICRODISTILLATION,
Limnologisch Inst., Nieuwersluis (Netherlands).
K. A. Hordijk, C. P. M. M. Hagenaars, and T. E. Cappenberg.
Applied and Environmental Microbiology, Vol. 49, No. 2, p 434-440, February, 1985. 5 Fig, 2 Tab, 23 Ref.

Descriptors: *Sediments, *Bacterial physiology, *Sulfates, *High pressure liquid chromatography, *Microdistillation, Sediment-water interface, Isotope studies.

Indirect photometric chromatography and microdistillation enabled a simultaneous measurement of sulfate depletion and sulfide production in the top 3 cm of freshwater sediments to be made. The simultaneous measurement of sulfate depletion and sulfide production rates provided added insight into microbial sulfur metabolism. The lower sulfate reduction rates, as derived from the production of acid-volatile S(2-)-35 only, were explained by a conversion of this pool to an undistillable fraction under acidic conditions during incubation. A mathematical model was applied to calculate sulfate reduction from sulfate gradients at the sediment-water interface. To avoid disturbance of these gradients, the sample volume was reduced to 0.2 g (wet weight) of sediment. Sulfate diffusion coefficients in the model were determined (D sub s = 0.000003 sq cm/s at 6 C). The results of the model were compared with those of radioactive sulfate turnover experiments by assessing the actual turnover rate constants (2 to 5/day) and pool sized of sulfate at different sediment depths. (Author's abstract)
W85-05053

GAS EXCHANGE-WIND SPEED RELATION MEASURED WITH SULFUR HEXAFLUORIDE ON A LAKE,
Lamont-Doherty Geological Observatory, Palisades, NY.
R. Wanninkhof, J. R. Ledwell, and W. S. Broecker.
Science, Vol. 227, No. 4691, p 1224-1226, March, 1985. 2 Fig, 1 Tab, 21 Ref.

Descriptors: *Gas exchange, *Wind speed, *Sulfur hexafluoride, *Lakes, Air-water interfaces, Fate of pollutants.

Gas-exchange processes control the uptake and release of various gases in natural systems such as oceans, rivers, and lakes. Not much is known about the effect of wind speed on gas exchange in such systems. In the experiment described here, sulfur hexafluoride was dissolved in lake water, and the rate of escape of the gas with wind speed (at wind speeds up to 6 meters per second) was determined over a 1-month period. A sharp change in the wind speed dependence of the gas-exchange coefficient was found at wind speeds of about 2.4 meters per second, in agreement with the results of wind-tunnel studies. However, the gas-exchange coefficients at wind speeds above 3 meters per second were smaller than those observed in wind tunnels and are in agreement with earlier lake and ocean results. (Author's abstract)
W85-05055

CRITICAL OXYGEN CONCENTRATION OF FINNISH LAKES,
R. Laaksonen, and V. Malin.
Vesientutkimuslaitoksen Julkaisuja, No. 49, p 54-57, 1982. 5 Fig, 1 Ref.

Descriptors: *Dissolved oxygen, *Finland, *Lakes, Seasonal variation, Monitoring, Water quality.

Data on observed oxygen concentrations in Finnish lakes are available in the water quality register from 16,969 observation sites for the period 1961-1980. Of these, 8504 had been sampled in March-April. On an individual lake basis, oxygen concentration was measured in 20-28% of Finland's 55,000-75,000 lakes, and the concentration at the end of the winter season was measured in 10-14% of the lakes. Oxygen concentrations below 11% of the saturation value were recorded at least once in 2353 of the observation sites examined in March-April (>5 m deep sites); a total of 2118 of the lakes investigated (28%) had at least on occasion a severe disturbance in the dissolved oxygen level. In one lake out of every four the bottom water layers were either totally or nearly totally oxygen depleted at the end of the winter season, with the result that the return of phosphorus from the bottom silt was significantly enhanced. Of the low-oxygen observation sites (O2 < 11% of saturation), over half contained low-oxygen water to a level of less than 21% of the height of the water column. The greatest frequencies of occurence of low oxygen lakes (O2 < 11%) varied considerably in different areas of the country: the greatest frequencies of occurrence were in the river Kokemaenjoki watercourse (38%) and in Ostrobothnia (35%; the minimum frequencies were in the river Kymijoki watercourse (21%), particulary in the southern part (18%), in the northern region of Lapland (19%), and in Northern Carelia (20%). The generality of low-oxygen lakes is to a large extent due to natural factors but the effects of human activities in certain regions are clearly discernable. (Collier-IVI)
W85-05064

QUANTITY AND COMPOSITION OF PHYTOPLANKTON, PARTICULARLY CHLOROPHYTA, IN LAKES OF DIFFERENT TROPHIC LEVELS,
R. Mantere, and P. Heinonen.
Vesientutkimuslaitoksen Julkaisuja, No. 49, p 58-63, 1982. 6 Tab, 19 Ref.

Descriptors: *Finland, *Phytoplankton, *Chlorophyta, *Trophic level, *Lakes, *Algae, Eutrophic lakes, Oligotrophic lakes, Species composition, Species distribution, Bioindicators, Water pollution effects.

The distribution and species composition of green algae was investigated in Finnish lakes of different trophic states and nutrient sources. All the samples were obtained from the Vuoksi river basin in

southeast Finland during June, July, and August of 1971 and 1977. The total phytoplankton biomass was lowest in the oligotrophic lakes, increasing considerably in cultural eutrophic lakes (where biomass was as much as ten times the corresponding level in natural eutrophic lakes). The species number of green algae increased with increasing eutrophication. The best indicator organisms for eutrophication were the green algae Kirchneriella contorta (Schmidle) Bohlin, Micractinium pusillum Fres. and Pediastrum duplex Meyen, P. Tetras (Ehrenb.) Ralfs. and P. boryanum (Turp.) Menegh. The only green algal species indicative of oligotrophy was Arthrodesmus incus (Breb.) Hass. The considerable increase in green algae in response to the mineralized nutrients of municipal waste waters implies that the monitoring of these organisms could possibly provide a means of investigating the effects of municipal effluents on recipient waters. (Collier-IVI)
W85-05065

LAKE WATER GEOCHEMISTRY OF TWO GEOLOGICALLY CONTRASTED AREAS IN KUUSAMO, NORTH-EASTERN FINLAND,
Oulu Univ. (Finland). Dept. of Geology.
R. Piispanen, and U. Myllymaa.
Vesientutkimuslaitoksen Julkaisuja, No. 49, p 64-75, 1982. 6 Fig, 2 Tab, 28 Ref, 1 Append.

Descriptors: *Geochemistry, *Lakes, *Kuusamo, *Finland, *Iijoki basin, *Koutajoki basin, Calcium, Magnesium, Potassium, Sodium, Iron, Manganese, Drainage basins, Hydrogen ion concentration.

Metal (Ca, Mg, K, Na, Fe, Mn) compositions of water in 48 lakes of moderate size (0.5-0.99 sq km) have been studied from two geologically contrasted drainage basins (the Iijoki and the Koutajoki systems) in Kuusamo North-eastern Finland. The lake waters within the Iijoki drainage area, which coincides with the Presvecokarelian basement complex (southern part of the area), carry less Ca and Mg and have lower pH, conductivity and alkalinity compared with the lake waters of the northern part of the area (the Koutajoki drainage basin) where the bedrock is composed mainly of rocks that belong to the Karelian formations. In the northern part the lake waters are rich in Ca (mean = 8.2 mg/l) and Mg (mean = 2.6 mg/l). This is obviously due to the existence of sedimentogeneous calcareous schists and carbonate albitites and spilitic carbonate veins in the substratum. On the basis of a test the differences between the drainage basins can be regarded as statistically very significant ($p < 0.001$) as to alkalinity and pH. The Koutajoki values for Ca and Mg are high, but those for K, Na and Fe low compared with Finnish lake waters in general. The contents of Ca and Mg are however lower than those of the world mean lake and river waters. Those of the Iijoki basin are nearly the same as the corresponding values in Norway, North Sweden and northwestern USSR. (Author's abstract)
W85-05066

INVERTEBRATE COLONIZATION OF SUBMERGED WOOD IN A CYPRESS-TUPELO SWAMP AND BLACKWATER STREAM,
Savannah River Ecology Lab., Aiken, SC.
J. H. Thorp, E. M. McEwan, M. F. Flynn, and F. R. Hauer.
American Midland Naturalist, Vol. 113, No. 1, p 56-68, January, 1985. 4 Fig, 3 Tab, 25 Ref, 2 Append. DOE contract DE-AC09-76SROO819.

Descriptors: *Invertebrates, *Swamps, *Blackwater streams, *Species composition, Ecological distribution, Distribution patterns, Species diversity, Midges, Mayflies.

The effects of location within a swamp-stream ecosystem on colonization rate and community structure of the macroinvertebrate assemblages of submerged wood were examined. Uniform-sized sections of freshly cut wood from water tupelo trees (Nyssa aquatica L.) were suspended below floating platforms at swamp and stream sites for periods of 1-8 weeks. The location of wood substratum affected community structure to a large degree and patterns of colonization to a slight extent. Logs in the swamp-tributary site held almost three times as many individuals and twice as many taxa as did logs in the swamp and outflow stream sites. Stream sites, however, were similar in proportions of various functional and taxonomic groups. Except for the abundance of true midges (Chironomidae), the densities of most major taxonomic groups were significantly affected by location within the swamp-stream ecosystem. Recruitment of individuals and species were extremely rapid and reached a rough steady state at most sites within 1 week. Filter-feeding taxa were numerically dominant early but soon were subordinate to gatherer and scraper functional feeding groups. This trend resulted primarily from the progressive increase in abundances of riffle beetles and mayflies. Current velocity, seston particle size, dispersal capacity and competition for space may be important factors affecting community structure and colonization patterns in this aquatic ecosystem. (Author's abstract)
W85-05120

CHARACTERISTICS OF THE FORMATION OF THE OXYGEN REGIME AND PH OF NATURAL WATER UNDER THE EFFECT OF SUBMERGED VEGETATION IN THE IVANKOVO RESERVOIR,
L. O. Elnor.
Water Resources, Vol. 11, No. 2, p 151-159, March-April, 1984. 3 Fig, 2 Tab, 31 Ref. Translated from Vodnye Resursy, No. 2, p 122-131, March-April, 1984.

Descriptors: *Submerged plants, *Dissolved oxygen, *Hydrogen ion concentration, *Ivankova Reservoir, *USSR, Aquatic plants, Macrophytes, Water quality, Rivers, Lakes, Reservoirs.

Aquatic plants are assumed to have a substantial effect on the formation of water quality, its ionic composition, and gas regime, and to actively participate in the self-purification processes. Despite the considerable complexity of the formation of the gas regime of a water body and especially the oxygen regime, it is necessary to clearly present the contribution of macrophytes to the formation of the oxygen regime, since the oxygen content in water in many respects determines the quality and biological properties of natural waters. The increasing shortage of biologically sufficient natural water necessitates the implementation of water resources development projects designed to aid processes of self-purification of biota in every possible way. As part of water projects, aquatic plants should be introduced, both from the standpoint of their participation in self-purification and their economic value as a raw material. In narrow, shallow brooks with low current velocities and predominant develoment of precisely submersed vegetation, vegetation has a decisive effect on water quality indices, including the gas regime. In the part of the littoral zone occupied by submersed vegetation the contribution of the vegetation to the formation of the oxygen regime is determined mainly by the level of its development. Although at a higher level of coverage submersed vegetation has a decisive effect on the formation of the oxygen regime and pH of natural water, under the real conditions of the Ivankovo reservoir, the proportion of stretches with a high level of coverage by submersed vegetation is small. The contribution of higher aquatic vegetation (specifically submersed vegetation) amounts to only several percent of the contribution of phytoplankton to photosynthetic production of oxygen. (Baker-IVI)
W85-05158

MODELING OF CO2 DYNAMICS IN A BODY OF FRESHWATER,
V. A. Alekseev, A. A. Georgiev, and A. O. Kokorin.
Water Resources, Vol. 11, No. 2, p 159-162, March-April, 1984. 2 Fig, 10 Ref. Translated from Vodnye Resursy, No. 2, p 132-135, March-April, 1984.

Descriptors: *Carbon dioxide, *Model studies, *Algal growth, *Photosynthesis, Algae, Temperature effects, Light intensity, Oxygen, Organic matter, Seasonal variation, Hydrogen ion concentration, Eutrophication.

A model was developed which would describe the dynamics of carbon dioxide in a water body and take into account the development of algae. The model was created on the basis of experiments conducted on the ETECOS (experimental ecosystem) device. Profiles of the temperature, light, pH, and concentration of oxygen and suspended organic particles were obtained as a result of the experiments. The conditions of the active photosynthesis of Chlorella during summer heating in the presence of calm weather were examined. The model represents a system of four nonlinear diffusion equations. The flow of carbon dioxide from the atmosphere cannot provide a carbon dioxide concentration sufficient for active bloom of the water body under conditions of summer heating and calm weather. The concentration of live Chlorella particles in the zone of active photosynthesis was about 15 mg dry wt/liter. The initial pH and alkalinity values were respectively 7.0 and 2.7 meq/liter. According to the model calculations, in this case the CO2 content in the zone of active photosynthesis drops to zero in 13 days. Its deficit will begin to strongly limit the photosynthetic process and growth of algae. Measurements of pH values and calculations of the amounts of assimilated carbon dioxide equivalent to them can be used for characterizing the photosynthetic rate. It is considered, however, that this method is less sensitive than the light and dark bottle technique in two modifications, oxygen and radiocarbon. The present model can also be used for evaluating what hydrodynamic conditions are the worst from the viewpoint of the quality of the water and oxygen regime of a water body. (Baker-IVI)
W85-05159

LIMNOLOGICAL STUDIES IN A CROSS-SECTION OF THE MIDDLE REACH OF PARANA RIVER, VI: WATER TEMPERATURE (ESTUDIOS LIMNOLOGICOS EN UNA SECCION TRANSVERSAL DEL TRAMO MEDIO DEL RIO PARANA, VI: TEMPERATURA DEL AGUA),
Instituto Nacional de Limnologia, Santo Tome (Argentina).
E. C. Drago.
Revista de la Asociacion de Ciencias Naturales del Litoral, Vol. 15, No. 1, p 79-92, September, 1984. 5 Fig, 4 Tab, 14 Ref.

Descriptors: *Parana River, *Argentina, *Water temperature, Air temperature, Flow discharge, Climate.

This paper deals with water temperatures at a cross-section of the middle reach of the Parana River and its relationships with the air temperature and discharge. During 1976-1981 the water temperature was vertically and transversely homogeneous. The maximum differences detected between surface and near-bottom waters (24 m depth) was 2.5 C. The highest temperatures were 30 C (26 Feb. 81) and 28.5 C (29 Dec. 77), respectively. The minimum temperature in those points was 12.9 C (18 June 79). The mean water temperature for the period was 21.84 C. Both the high water discharge flowing through the studied cross-section and its origin in warm regions influence the water temperature, damping its daily and seasonal fluctuations and minimizing the differences along the middle reach. Air temperature is the main factor responsible for thermal variations in the river temperature. Linear correlations between the mean water temperature in the middle of the channel and the average of daily mean maximum air temperatures during the 30 days previous to sampling data were performed. The best relationships were found with water temperature lagging 15 days behind air temperatures ($r = 0.95$, $p < 0.001$ and $r = 0.94$, $p < 0.001$, respectively). The monthly mean air temperature was also closely related to the mean water temperature ($r = 0.93$, $p < 0.001$). (Author's abstract)
W85-05177

PLANKTON OF TWIN LAKES, COLORADO,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
D. M. Lieberman.

Available from the National Technical Information Service, Springfield, VA 22161. Report REC-ERC-82-21. February 1983. 17 p, 15 Fig, 3 Tab, 16 Ref, 1 Append.

Descriptors: *Phytoplankton, *Zooplankton, *Taxonomy, *Environmental effects, *Powerplants, *Lakes, Limnology, Shrimp, Copepods, Rotifers, Diatoms, Chlorophyta, Chrysophyta, Cyanophyta, Algae, Crustaceans, Aquatic environment, Fauna, Flora, Pumped storage, Systematics, Twin Lakes, Mt. Elbert Pumped-Storage Powerplant, Colorado.

The effects were studied of the Mt. Elbert Pumped-Storage Powerplant on the ecology of Twin Lakes. Twin Lakes are a pair of connected dimictic lakes, formed as the result of glacial action on alluvial deposits. A taxonomic species study is presented of the common plankton collected since 1974 from Twin Lakes. A total of 11 zooplankters and 14 phytoplankters were identified from the limnetic zone of Twin Lakes and the associated Mt. Elbert Forebay. The four divisions of zooplankton included four species of Rotifera, three species of Copepoda, three species of Cladocera, and one species of Mysidacea. The dominant zooplankters were the rotifers and copepods. The nocturnal opossum shrimp, Mysis relicta are abundant in Twin Lakes but were not collected in plankton samples. Cladocerans were rarely collected and made up less than 1 percent of the zooplankton population. The lower lake has a greater density of zooplankton than the upper lake. The four divisions of phytoplankton included three species of Chrysophyta, three species of Chlorophyta, six species of Bacillariophyta (diatom), and two species of Cyanophyta. The phytoplankton was dominated by the yellow-brown algae, Dinobryan, and the diatoms, Asterionella and Synedra. During 1981, average density of phytoplankton reached a maximum of 4870 organisms/liter during September in the upper lake; the average density in the lower lake peaked during March at 18,042 organisms/liter. (See also W80-02049, W81-05743, and W82-06403)
W85-05303

EFFECTS OF OPERATING THE MT. ELBERT PUMPED-STORAGE POWERPLANT ON TWIN LAKES, COLORADO: 1981 REPORT OF FINDINGS,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
J. F. LaBounty, and J. J. Sartoris.
Available from the National Technical Information Service, Springfield, VA 22161. Report REC-ERC-83-2. December 1982. 88 p, 62 Fig, 24 Tab, 44 Ref, 2 Append.

Descriptors: *Aquatic environments, *Lakes, *Ecological effects, *Powerplants, *Limnology, *Baseline studies, Dissolved oxygen, Nitrogen, Phosphorus, Chlorophyll, Conductivity, Phytoplankton, Zooplankton, Benthos, Hydrogen ion concentration, Twin Lakes, Colorado, Pumped storage, Environmental effects, Fish, Entrainment, Mt. Elbert powerplant.

A series of studies is being performed to identify and quantify changes in the aquatic ecology of Twin Lakes due to the Mt. Elbert Pumped Storage Powerplant operations which began in 1981. Since it is too early to identify any ecological changes, these results along with those from other studies done since 1971 are being used to define the preoperational limnology of Twin Lakes. Maximum water temperature for both lakes recorded in August 1981 was 18 C. The lowest measured dissolved oxygen concentration during 1981 was 1.7 milligrams/liter. The pH ranged between 6.5 and 8.3, and conductivity levels were between 69 and 102 micro S/cm. Total P concentrations ranged from < 1 micrograms/liter to 31 micrograms/liter. Nitrate N concentrations ranged from < 10 to 170 micrograms/liter. Average daily primary productivity rates ranged from a low of 84 milligrams C/sq m/day during March to a high of 126.6 milligrams C/sq m/day during May. Chlorophyll a concentrations ranged from 0.4 milligrams/cu m to 18.8 milligrams/cu m. Average phytoplankton and zooplankton densities reached maximums of just over 18000 organisms/liter (September 1981) and 153 individuals/liter (June 1981), respectively. The benthos includes chironomid larvae, oligochaetes, and fingernail clams. (See also W78-03838, W79-09424, and W81-00844)
W85-05304

REGIONAL SURVEY OF CHEMISTRY OF HEADWATER LAKES AND STREAMS IN NEW ENGLAND: VULNERABILITY TO ACIDIFICATION,
Columbia National Fisheries Research Lab., Orono, ME. Field Research Station.
T. A. Haines, and J. Akielaszek.
Report FWS/OBS-80/40.15; Air Pollution and Acid Rain Report 15, April 1983. 141 p, 44 Fig, 26 Tab, 71 Ref, 2 Append.

Descriptors: *Lakes, *Acidity, *Acidification, *Acid rain, *Alkalinity, Surveys, Model studies, *Hydrogen ion concentration, Chemical properties, Water analysis, Streams, Trace elements, Calcium, Bedrock, Acidic water, New England, Surface water.

A survey was conducted of 226 headwater lakes and low order streams of the six New England states to assess the status of these waters with respect to acidification from air pollution and acid rain. Approximately 59% of the waters surveyed had high calcite saturation indices and were considered susceptible to acidification. Alkalinity was considered the best measure of vulnerability to acidification and bedrock geology was the best physical factor that could be used to predict surface water alkalinity. Both historical water chemistry comparisons and acidification models indicate that the vulnerable lakes have declined in alkalinity and increased in hydrogen ion content, presumably as a result of atmospheric deposition of acid. About 8% of the waters surveyed were acidic (pH less than 5.0), had elevated aluminum concentration (greater than 200 micrograms per liter), or both, conditions that may be toxic to sensitive fish species. (See also W75-01473)
W85-05312

WEAK ACID/BASE SYSTEMS IN DILUTE ACIDIFIED LAKES AND STREAMS OF THE ADIRONDACK REGION OF NEW YORK STATE,
Syracuse Univ., NY. Dept. of Civil Engineering.
C. T. Driscoll, and J. J. Bisogni.
In: Modeling of Total Acid Precipitation Impacts. 1984. p 53-72, 5 Fig, 9 Tab, 28 Ref.

Descriptors: *Acidification, *Acidic water, *Hydrogen ion concentration, *Lakes, *Bases, *Organic acids, *Neutralization, *Model studies, *Organic carbon, Acids, Aluminum, Acid rain, Streams, Hydrologic models, Water quality, Chemical properties, Organic matter, Big Moose Lake, North Lake, Little Moose Lake.

Attempts were made to quantify the weak acid/base chemistry of dilute acidified lake and stream systems in the Adirondack Mountain region of New York State. Samples were collected over an annual cycle at 24 sites from three lakes (Big Moose Lake, North Lake, and Little Moose Lake) and eight tributaries. Analyses of water quality parameters and acid neutralizing capacity (ANC) were performed on samples taken on 15 sampling dates. Adirondack waters had a greater ANC than expected based on equilibrium with atmospheric CO2. The difference between measured ANC and theoretical ANC in equilibrium with atmospheric CO2 might be considered to be the residual ANC consisting of Al or natural organic matter. Natural organic acids were fit to monoprotic proton dissociation constant model and the total, organic C proton dissociation/association sites were observed to be empirically correlated to total organic C concentration. Al levels appear to fit an Al trihydroxide solubility model. Al buffering appears to control the lower limit of pH value observed in Adirondack waters.
W85-05316

COMPARISON OF SEASONAL AND DIURNAL PATTERNS OF SOME PHYSICO-CHEMICAL PARAMETERS OF THE OPEN AND CLOSED PARTS OF LOKTAK LAKE, MANIPUR, INDIA,
Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences.
D. K. Banerjee, B. Bhatia, and I. Haq.
International Journal of Environmental Studies, Vol. 21, No. 3/4, p 243-250, October, 1983. 9 Fig, 1 Tab, 25 Ref.

Descriptors: *Loktak Lake, *India, *Physicochemical properties, *Seasonal variation, *Diurnal variation, Dissolved oxygen, Carbon dioxide, Hydrogen ion concentration, Calcium, Water pollution.

Loktak Lake, situated near Imphal, India has a total area of about 69,120 acres of which the closed part occupies about 518 hectares. The closed part of the lake is well protected and not subject to any human intervention except controlled fishing. The open lake is subject to uncontrolled fishing, dumping of human wastes and pollution from its input waters. Water samples were collected from the surface and the bottom between December 1977 and December 1978. In both the open as well as the closed lake the pH displayed a clear seasonal variation, with the highest values in winter and the lowest values during the post monsoon period. The pH values were somewhat lower at the bottom than at the surface during most of the period. In the open lake, dissolved oxygen (DO) displayed high values during winter and low values in the post monsoon period. In the closed lake there was no pattern of seasonal change in the DO. Diurnal patterns were discernible, both in the closed and open lakes. Free carbon dioxide values in the bottom samples from the closed lake were lower in the daytime and higher at night. This pattern was not consistently observed for the surface samples. The pH values were high during the day and low at night. Calcium variations were opposite to those of the pH for bottom samples of closed lake, but not of open lake. The diurnal patterns of the open lake were quite different from those of the closed lake. Deviations from the normal expected diurnal variation pattern of simple physicochemical parameters and of the relationship between these may possibly serve as a useful criterion of the degree of perturbation to which a lake is subjected due to human or natural causes. (Baker-IVI)
W85-05444

GROWTH STUDIES OF AZOLLA PINNATA RBR. IN A PERMANENT POND,
Indian Inst. of Tech., New Delhi. Centre for Rural Development and Appropriate Technology.
For primary bibliographic entry see Field 5D.
W85-05447

ENHANCED LONGITUDINAL MIXING IN A LAKE CAUSED BY INFLOW-INDUCED CIRCULATION,
Connecticut Agricultural Experiment Station, New Haven. Dept. of Ecology and Climatology.
F. J. Ferrandino, and D. E. Aylor.
Water Resources Research, Vol. 21, No. 2, p 221-228, February, 1985. 7 Fig, 1 Tab, 14 Ref.

Descriptors: *Lake Lillinonah, *Connecticut, *Mixing, *Water circulation, Destratification, Seasonal variation, Lakes, Alkalinity, Tracers, Inflow, Entrainment, Countercurrent flow.

The course of mixing during the summer between the two basins of Lake Lillinonah (Connecticut) was observed using alkalinity as a natural tracer of water movements. The net alkalinity flux from the large to the small basin was shown to be related to the rate of buoyant energy input delivered to the small basin by the inflowing river. A portion of this power goes into the creation of a longitudinal circulation via the process of entrainment. The cold inflow plunges and follows the bottom of the reservoir entraining ambient water into the underflow. The entrained water is replaced by a shallow return flow. The observed interbasin alkalinity flux can be accounted for if the incoming waters entrain an equal volume of ambient water as it enters the reservoir. The order of magnitude of the associated countercurrent flow is consistent with direct

observation of water movement. Some of the buoyant energy delivered by the inflowing river is stored in the potential energy of thermal stratification: isopycnals are tilted upward toward the inflow. During early summer as the inflow decreases rapidly, this stored energy is released, setting up transient flows which temporarily enhance the interbasin exchange of water. A three-layer model, incorporating the above two inflow-induced mixing processes, accounts for 90% of the mixing observed over the course of a summer. (Baker-IVI)
W85-05501

PRIMARY AND BACTERIAL PRODUCTION IN TWO DIMICTIC INDIANA LAKES,
Georgia Univ., Athens. Dept. of Biochemistry.
C. R. Lovell, and A. Konopka.
Applied and Environmental Microbiology, Vol. 49, No.3, p 485-491, March, 1985. 7 Fig, 3 Tab, 23 Ref. NSF grant DEB-8201857 and OWRT grant B-127:IND.

Descriptors: *Indiana, *Crooked Lake, *Little Crooked Lake, *Bacteria, *Primary productivity, Seasonal variation, Vertical distribution, Lakes, Rainfall, Thymidine, Dimictic lakes.

The relationship between bacterial production and primary production was studied in two dimictic lakes that have significant levels of metalimnetic primary production. The study was conducted on Crooked and Little Crooked Lakes in Noble County, Indiana. Bacterial production was related to primary production with respect to both vertical and seasonal distribution in the water columns of both lakes. A lag of about 2 weeks between a burst in primary production and the subsequent response in bacterial production was noted. The vertical distribution of bacterial production in the water column of the less productive lake, Crooked Lake, was determined by the vertical distribution of primary production, but no clear relationship between seasonal maxima of primary and bacterial production in this lake was noted. High rates of bacterial production in Crooked Lake during May indicate the importance of allochthonous carbon washed in by spring rains. Bacterial production accounted for 30.6 and 31.8% of total production in Crooked Lake and Little Crooked Lake, respectively from April through October. High rates of bacterial production during late September and October were observed in both lakes. Calculation of the fraction of bacterial production supported by phytoplankton excretion implies an important role for other mechanisms of supplying carbon, such as phytoplankton autolysis. Several factors affecting the calculation of bacterial production from the thymidine incorporation rates in these lakes were examined. (Baker-IVI)
W85-05507

SEASONAL BACTERIAL PRODUCTION IN A DIMICTIC LAKE AS MEASURED BY INCREASES IN CELL NUMBERS AND THYMIDINE INCORPORATION,
Georgia Univ., Athens. Dept. of Biochemistry.
C. R. Lovell, and A. Konopka.
Applied and Environmental Microbiology, Vol. 49, No. 1, p 492-500, March, 1985. 6 Fig, 5 Tab, 28 Ref. NSF grant DEB-8201857 and OWRT grant B-127:IND.

Descriptors: *Bacteria, *Primary productivity, *Seasonal variation, *Little Crooked Lake, *Indiana, Eutrophic lakes, Vertical distribution, Dimictic lakes, Isotopic tracers, Thymidine.

The rates of incorporation of C-14 labeled HCO3(-) and H-3 labeled methyl thymidine were used to determine rates of primary and bacterial production, respectively in Little Crooked Lake, Indiana. Growth rates of bacteria in diluted natural samples were determined for epilimnetic and metalimnetic bacterial populations during the summers of 1982 and 1983. Exponential growth was observed in these diluted samples, with increases in cell numbers of 30 to 250%. No lag was noted in bacterial growth in 14 of 16 experiments. Doubling times of natural bacteria calculated from thymidine incorporation rates and in situ cell numbers ranged from 0.35 to 12.00 days (median, 1.50 days). Bacterial production amounted to 66.7 g C/sq m from April through September, accounting for 29.4% of total production during this period. The vertical and seasonal distribution of bacterial production in Little Crooked Lake was strongly influenced by the distribution of primary production. From April through September 1983, the depth of maximum bacterial production rates in the water column was related to the depth of high rates of primary production. On a seasonal basis, primary production increased steadily from May through September, and bacterial production increased from May through August and then decreased in September. (Baker-IVI)
W85-05508

THYMIDINE INCORPORATION BY FREE-LIVING AND PARTICLE-BOUND BACTERIA IN A EUTROPHIC DIMICTIC LAKE,
Georgia Univ., Athens. Dept. of Biochemistry.
C. R. Lovell, and A. Konopka.
Applied and Environmental Microbiology, Vol. 49, No. 3, p 501-504, March, 1985. 3 Tab, 26 Ref. NSF grant DEB-8201857 and OWRT grant B-127:IND.

Descriptors: *Bacteria, *Cyanophyta, *Little Crooked Lake, *Indiana, Thermal stratification, Primary productivity, Eutrophic lakes, Dimictic lakes, Thymidine.

In Little Crooked Lake (Indiana), filamentous cyanobacteria are present as the dominant phytoplankton type throughout the period of thermal stratification. The percentage of H-3 labeled methyl thymidine incorporated into samples from this dimictic eutrophic lake and retained on polycarbonate membranes of 3.0-, 1.0-, and 0.2 micro-m pore size was studied. Overall, particle-bound production accounted for only 2 to 19% of total bacterial production from April to August in all water layers. It appears that the supply of colonizable particles (damaged cyanobacterial filaments) is an important factor affecting the level of particle-bound bacterial activity in this lake. (Baker-IVI)
W85-05509

ANNUAL CYCLE OF BACTERIAL SECONDARY PRODUCTION IN FIVE AQUATIC HABITATS OF THE OKEFENOKEE SWAMP ECOSYSTEM,
Georgia Univ., Athens. Inst. of Ecology.
R. E. Murray, and R. E. Hodson.
Applied and Environmental Microbiology, Vol. 49, No. 3, p 650-655, March, 1985. 3 Fig, 2 Tab, 34 Ref. BSR grants 8215587 and 8114823.

Descriptors: *Bacteria, *Okefenokee Swamp, *Aquatic habitats, *Productivity, Secondary production, Annual cycle, Seasonal variation, Organic carbon, Particulate matter, Dissolved solids.

Rates of bacterial secondary product from five aquatic habitats (four prairies and one open-water lake) in the Okefenokee Swamp are reported. While it is not possible to measure bacterial uptake of each individual potential substate, bacterial secondary production by free-living bacteria is a conservative estimate of the rate of turnover of the available dissolved organic carbon pool. An understanding of the seasonal dynamics of bacterial production thus provides information concerning both the seasonal availability of high-quality particulate organic carbon (the bacterial biomass itself) and the seasonal fate of dissolved organic carbon (DOC) released by primary producers. Bacterial secondary production was found to be seasonally high, varying by up to 98-fold over the year, and paralleling the annual cycle of macrophyte growth and decomposition. The high rates of bacterial secondary production suggest that the transformation of DOC into high quality bacterial biomass is an important process in the flow of energy from primary producers to other trophic levels. (Baker-IVI)
W85-05512

TEMPERATURE AND LIGHT EFFECTS ON THE GROWTH OF POTAMOGETON CRISPUS IN COLLINS LAKE, NEW YORK STATE,
Union Coll., Schenectady, NY. Dept. of Biology.
For primary bibliographic entry see Field 4A.
W85-05523

MODEL USE AND VERIFICATION OF ECOLOGICAL PARAMETERS FOR AN OLIGOTROPHIC LAKE (LAKE STECHLIN, G.D.R.),
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
R. Koschel, and P. Kasprzak.
Ecological Modelling, Vol. 26, No. 1/2, p 97-101, December, 1984. 2 Fig, 2 Tab, 5 Ref.

Descriptors: *Oligotrophic lakes, *Model studies, *Ecology, *Lake Stechlin, *Germany (Democratic Republic), Lakes, Plankton, Biomass, Algal growth, Zooplankton, Phytoplankton, Productivity, Simulation.

The applicability of an ecological model (SALMO) was tested for the oligotrophic Lake Stechlin. For the simulation of production processes of Lake Stechlin the model was slightly modified by the inclusion of water inflow and outflow. Comparison of the computed and observed parameters for 1974 and 1975 indicated that better consideration of biological and space inhomogeneities of the water body and deeper causal analysis of plankton growth and loss factors are wanted. The pytoplankton values show a better agreement in 1975 than in 1974. In 1975 the input of the nuclear power plant's cooling water was low. The simulated and measured seasonal periodicity and values of zooplankton biomass show considerable discrepancies. Several conclusions regarding the use of the model are noted including improved consideration and registration of biological and space inhomogeneities of the water body; deeper causal analysis of factors controlling zooplankton and phytoplankton growth; and better specification and investigation of ecological loss-factors for zooplankton and phytoplankton. (Baker-IVI)
W85-05602

TESTING OF A COMPLEX ECOLOGICAL MODEL FOR SHALLOW WATER BODIES,
Akademie der Wissenschaften der DDR, Berlin. Inst. fuer Geographie und Geooekologie.
H.-P. Kozerski, G. Schellenberger, H. Behrendt, and V. Mohaupt.
Ecological Modelling, Vol. 276, No. 1/2, p 103-113, December, 1984. 7 Fig, 12 Ref.

Descriptors: *Model studies, *Shallow water, *Lake Muggelsee, *Germany (Democratic Republic), Eutrophic lakes, Phosphorus, Nitrogen, Phytoplankton, Algae, Diatoms, Bacteria, Zoobenthos, Organic matter, Sedimentation.

A 15 component model has been developed and tested in three steps, which run from tests of the submodels to tests of the complete model on new independent data from the Lake Muggelsee (German Democratic Republic). The model has been used for a network of five interrelated lakes of the Spree-Dahme river system southeast of Berlin. The retention times range from some days to one and a half months. The aim of the ecosystem model is to improve understanding and to predict the changes in water quality of the lake. The components phytobenthos, zoobenthos, zooplankton and fish seem to be of relatively small importance for water quality in this eutrophic lake and were thus neglected. From the tests performed it is demonstrated that the model is able to give a good description and prediction of the general dynamics of algae and nutrients sufficient for purposes of water management. The main areas where additional work is needed are the better determination of ecophysiological coefficients of algae, the effects of light and temperature on phytoplankton, and hydrodynamic problems. (Baker-IVI)
W85-05603

FIELD STUDIES ON THE BREAKDOWN OF NUPHAR LUTEA (L.) SM. (NYMPHAEACEAE), AND A COMPARISON OF THREE MATHEMATICAL MODELS FOR ORGANIC WEIGHT LOSS,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
T. C. M. Brock, M. J. H. de Lyon, E. M. J. M. Van Laar, and E. M. M. Van Loon.
Aquatic Botany, Vol. 21, No. 1, p 1-22, January, 1985. 5 Fig, 4 Tab, 47 Ref.

Descriptors: *Aquatic plants, *Decomposition, *Waterlily, Macrophytes, Nitrogen, Phosphorus, Potassium, Detritus, Nutrients.

Aspects of the decomposition of the aquatic macrophyte Nuphar lutea were studied using the litter bag method in the field. The organic weight loss during breakdown was described by means of 1 simple and 2 composite exponential models. The nitrogen, phosphorus and potassium concentration of the remaining detritus were analyzed. It appeared that the in situ breakdown of the Nuphar detritus was described beter by the composite exponential models than by the simple exponential model. In most cases the 2-component model showed a slightly better description than the decaying coefficient model. Some plant parts of Nuphar lutea showed significant differences in breakdown rate. The roots and root stocks of Nuphar lutea both have a longer life span and a slower breakdown than other parts. The slower breakdown of roots and root-stocks can be explained in part by their low initial nitrogen levels. The disappearance of the decomposing Nuphar lutea leaves from the litter bags is influenced by seasonal factors. The breakdown of the coarse detritus was significantly faster in summer than in autumn. The patterns of nitrogen, phosphorus and potassium dynamics of the decomposing Nuphar material were dependent on the type of plant part, the season and the system. In all parts of this study the Nuphar detritus showed at least a temporary increase in nitrogen concentration. While it is evident that in the field numerous factors influence the decay and nutrient dynamics of macrophyte detritus, some factors will be more important than others. (Baker-IVI)
W85-05606

BREAKDOWN OF MACROPHYTES IN A RESERVOIR WETLAND,
Texas Univ. at Dallas, Richardson. Inst. for Environmental Sciences.
B. H. Hill.
Aquatic Botany, Vol. 21, No. 1, p 23-31, January, 1985. 2 Fig, 3 Tab, 30 Ref.

Descriptors: *Aquatic plants, *Decomposition, *Wetlands, Texas, Reservoirs, Macrophytes, Invertebrates, Flooding, Cattails.

The rate of aquatic plant decay in a freshwater wetland adjacent to a Texas reservoir was determined. The effects of inundation and exposure on macrophyte decay and the colonization of decaying macrophytes by aquatic macroinvertebrates were also studied. The wetland experienced periods of exposure and inundation because of annual variations in stream flow and evaporation. Exposure of the wetland community in this ecosystem occurred in the autumn about the time of macrophyte senescence. Inundation of the exposed wetland occurred by late autumn. Weight losses from leaf laminae and petioles of Nelumbo lutea, and from leaves of Ludwigia leptocarpa and Typha angustifolia were measured by exposing leaf material in mesh bags. The Nelumbo leaf laminae decayed faster than all other litter types while Nelumbo leaf petioles decayed the slowest. The relative breakdown rates were: Nelumbo leaf laminae > Ludwigia > Typha > Nelumbo leaf petioles. Macro invertebrate colonization of litter bags was initially low, then increased rapidly by the 15th day of exposure. Numbers of macroinvertebrates declined sharply following the peak for all litter types except Nelumbo leaves, perhaps reflecting the higher palatability and food quality of the Nelumbo leaves. Macroinvertebrate numbers on the Nelumbo leaves litter packs remained high through the first 65 days of the study, then declined rapidly. The functional feeding group composition of the macro-invertebrate aggregation colonizing leaf bags was similar for all types of plant litter and did not change throughout the study. (Baker-IVI)
W85-05607

PREDICTIONS OF VEGETATION CHANGE FOLLOWING FIRE IN A GREAT SALT LAKE MARSH,
Utah State Univ., Logan. Dept. of Fisheries and Wildlife.
L. M. Smith, and J. A. Kadlec.
Aquatic Botany, Vol. 21, No. 1, p 43-51, January, 1985. 4 Tab, 21 Ref.

Descriptors: *Salt marshes, *Revegetation, *Fire, *Great Salt Lake, *Utah, *Succession, *Species composition, Model studies, Gleasonian models, Marshes, Plant growth, Shade, Light intensity.

A Gleasonian model of succession was used to predict the species composition of a freshwater marsh following fire. Seed bank samples from 5 vegetation types were used in conjunction with plant life history characteristics to make predictions of post-fire species composition for each vegetation type and the entire study area. Vegetation regrowth was rapid in Typha spp, Scirpus lacustris and S. maritimus sites, but very limited in Distichlis sites and therefore, shade tolerance was an important factor in predictions. Model predictions of marsh plant species composition following the fire were not good for the specific vegetation types of Scirpus lacustris, S. maritimus, Distichlis spicata and open water. Much of the lack of agreement between predictions and field data may have been due to shade classifications. Shade may directly reflect substrate temperature. There was good agreement between prediction and actual species occurrence for Typha spp. vegetation and for the total study area. (Baker-IVI)
W85-05608

EFFECTS OF NITRATE, PHOSPHATE AND POTASSIUM FERTILIZATION ON GROWTH AND NUTRIENT UPTAKE PATTERNS OF PHRAGMITES AUSTRALIS (CAV.) TRIN. EX STEUDEL,
Michigan State Univ., East Lansing. Dept. of Zoology.
K. E. Ulrich, and T. M. Burton.
Aquatic Botany, Vol. 21, No. 1, p 53-62, January, 1985. 8 Fig, 1 Tab, 10 Ref. OWRT grant B-055-MICH.

Descriptors: *Plant growth, *Nitrates, *Phosphates, *Potassium, *Reeds, Nutrients, Fertilizers, Plants, Aquatic plants.

Emergent aquatic plants have great potential for nutrient uptake from sewage-enriched substrates and for biomass production. Phragmites australis, a herbaceous perennial emergent aquatic plant, is an excellent species for culture because of its high capacity for biomass production. The effects of independently varied additions of nitrate, phosphate and potassium upon the growth and nutrient uptake patterns of P. australis were examined. P. australis shoot growth and root plus rhizome growth were heavily influenced by nitrate and phosphate treatments and their interactions. Potassium fertilization had no effect on plant growth or nutrient uptake. Distribution of plant net primary production between above-ground and below-ground tissues was most heavily influenced by the nitrate supply. Use of high nitrate levels may more than double the proportion of above-ground as compared to below-ground tissues. Shoot production was maximized by the highest treatment level of nitrate coupled with the two highest treatment levels of phosphate (3.88 and 7.81 g/sq m). Production levels of large-scale plantings of P. australis might be lower than that found for isolated tubs because of the likelihood of increased self-shading and competition for carbon dioxide. (Baker-IVI)
W85-05609

STUDIES ON THE BOTTOM SEDIMENTS AND EPIPELIC ALGAE OF THE RIVER ELY, SOUTH WALES, U.K.,
University Coll., Cardiff (Wales). Dept. of Plant Science.
For primary bibliographic entry see Field 5C.
W85-05611

AMMONIFICATION AS AFFECTED BY THE OXYGEN LEVEL OF WATER,
Kalyani Univ. (India). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W85-05615

RELATIONSHIPS BETWEEN PHOSPHORUS LOADING AND TROPHIC STATE IN CALCAREOUS LAKES OF SOUTHEAST WISCONSIN,
Wisconsin Univ.-Madison. Water Chemistry Lab.
For primary bibliographic entry see Field 5C.
W85-05620

CHANGES IN CLADOCERA COMMUNITY STRUCTURE AND FOSSIL PIGMENT STRATIGRAPHY AS COMPARED TO THE FIRE HISTORY OF ELK LAKE, CLEARWATER CO., MN, U.S.A.,
Indiana Univ. at Bloomington. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W85-05624

VARVE-DATED EUTROPHICATION HISTORY OF A SMALL LAKE,
Joensuu Univ. (Finland). Karelian Inst.
For primary bibliographic entry see Field 5C.
W85-05628

PHOSPHORUS RELEASE FROM THE SEDIMENTS OF FLAMING GORGE RESERVOIR, WYOMING, U.S.A.,
Utah Water Research Lab., Logan.
J. J. Messer, J. M. Ihnat, and D. L. Wegner.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1457-1464, December, 1984. 2 Fig, 3 Tab, 20 Ref.

Descriptors: *Sediments, *Phosphorus, *Flaming Gorge Reservoir, *Wyoming, Reservoirs, Eutrophication, Iron, Lake restoration, Chlorophyta, Anoxic conditions.

Flaming Gorge Reservoir is a mainstem reservoir on the Colorado River in semi-arid southern Wyoming, having a maximum capacity of 5 x 10 to the 9th power cu m and a length of 145 km. Following complete filling of the reservoir in 1973 extensive blooms of blue-green algae have occurred in both of the upper arms of the reservoir whose hypolimnia become anoxic during 1-3 months in the late summer. Sediments in the two upper arms are characterized by highly different phosphorus chemistry. The Blacks Fork arm is low in Fe and non-apatite inorganic P, while the Green River arm is high in both of these species. Apatite-P values are high and similar in both arms. P release rates determined in laboratory simulations using intact cores ranged from 0.10 to 11.1 mg P/sq m/day, and were significantly higher under anaerobic conditions. Anaerobic release rates were highly correlated with NaOH-extractable P concentrations. Effects of the extraction procedure on the apparent NaOH-P concentration were highly apparent, but the correlation between P release and sediment P concentration remained strong for all extraction techniques. The particular technique used may have potential for predicting the necessity for sediment P immobilization in lake restoration programs. (Baker-IVI)
W85-05630

PATTERNS OF PHYTOPLANKTON POPULATIONS AND THEIR RELATIONSHIP TO TROPHIC STATE IN AN ELONGATE RESERVOIR,
Baylor Univ., Waco, TX. Dept. of Biology.
O. T. Lind.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1465-1469, December, 1984. 2 Fig, 2 Tab, 5 Ref.

Descriptors: *Reservoirs, *Belton Reservoir, *Texas, *Trophic levels, *Eutrophication, *Phytoplankton, Population dynamics, Limnology, Nutrients, Transparency, Chlorophyll.

In many reservoirs the trophic state gradient is difficult to detect by the use of trophic state indices which are based on light extinction by the phytoplankton populations because of intense inorganic silt suspensions. Belton Reservoir in central Texas is an exception. This elongate and sinuous reservoir receives little inorganic silt and in its trophic state relations functions as a typical lake. Thus it is suited to the study of linear gradients of nutrient concentrations, trophic states, transparency, and to the possible establishment of discrete values of biotic variables. The spatial heterogeneity among phytoplankton populations at five locations along this trophic state gradient were examined by use of a similarity index. A doubling in the concentration of phytoplankton produced an increase in the trophic state index of ten, from 40 to 50. The trophic state indices calculated for Belton Reservoir by both Secchi disk and chlorophyll each decreased along the gradient from headwaters to dam. Phytoplankton population during summer and autumn were approximately four times less near the dam than in the headwaters. Phytoplankton populations were very heterogeneous. Recognizably different populations were present along the long axis with its strong gradient of trophic states. Because of their elongate configuration, reservoirs will probably have greater heterogeneity than lakes of similar area. Belton Reservoir has a flushing rate of about once per year, and therefore may be typical of conditions necessary to promote a high amount of heterogeneity. (Baker-IVI)
W85-05631

LEAF LITTER PROCESSING IN A VIRGINIA RESERVOIR: THE ROLE OF TEMPERATURE AND FISH,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
A. C. Hendricks, G. Simmons, Jr., and F. Taylor.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1482-1485, December, 1984. 2 Fig, 2 Tab, 7 Ref.

Descriptors: *Leaves, *Litter, *Reservoirs, *Virginia, Temperature effects, Fish, Invertebrates, Microorganisms.

There appear to be a number of ways in which a leaf can become fragmented. An experimental leaf processing study was performed in a reservoir and a role for larger vertebrates in the processing of leaves is suggested. Maple leaves were exposed for periods of one, two and three months in enclosed and open units with or without fish. Significant differences between processing rates were found at the end of the first 91 day period, at the end of 63 days, and at the end of the second 91 day period. These data suggest that larger organisms, probably the fish, were playing a role in processing the leaves in the open trays as they did not have access to the leaves in the enclosures. Microorganisms played a critical role during the first month of processing and their activities were tied closely to the temperature of the water. The invertebrate shredders probably contributed to the leaf processing in the spring and early summer. Fish seemed to play an important role in leaf processing particularly in the advanced stages of processing. (Baker-IVI)
W85-05632

EFFECTS OF URBAN STORMWATER RUNOFF ON RESERVOIR PHYTOPLANKTON,
George Mason Univ., Fairfax, VA. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W85-05633

PRIMARY PRODUCTION AND ITS FATE IN THE STORAGE BASIN OF MERY-SUR-OISE,
Ecole Normale Superieure, Paris (France). Lab. de Geologie.
S. Dessery, C. Lancelot, and G. Billen.
Verhandlung Internationale Vereinigung Limnologie Vol. 22, No. 3, p 1504-1509, December, 1984. 2 Fig, 3 Tab, 3 Ref.

Descriptors: *River Oise, *Mery-sur-Oise Basin, *France, *Primary productivity, *Zooplankton, *Bacterioplankton, Sedimentation, Carbon, Carbon cycle.

The basin of Mery-sur-Oise is an artificial basin, fed by the river Oise and used as a storage reservoir for a drinking water plant. Its volume is about 400,000 cu m, with an average depth of 9 m. Water from the Oise is injected with high energy, preventing any stratification of the water column. The mean residence time of the water is about 4 days. The river Oise at Mery is about 75 m wide and 5 m deep. Its mean annual discharge is about 150 cu m/sec, but values of 50 cu m/sec for summer are typical. A comparison between these two ecosystems offers a unique opportunity to study the effects of some physical and morphological factors on the biological function of aquatic systems. Primary production, zooplankton grazing, bacterioplankton activity and sedimentation were measured during the year 1982 in the river Oise and in the basin of Mery-sur-Oise. A carbon budget was established for the summer period in both environments. In the basin dissolved primary production remains at about 5% of particulate production. The inputs of allochthonous organic material largely dominate the autochthonous primary production. In the summer, zooplankton, including cladocerans, copepods and rotifers, ingest daily about 10% of the phytoplankton biomass. This represents about 1 g C/sq m/day, or about 17% of the total flux of imported and produced phytoplankton. Budget calculations show that 47% of the latter flux is exported with the outflow, while 26% is deposited on the bottom and 8% is lysed and degraded by planktonic bacteria, which appear to utilize mostly allochthonous dissolved organic carbon. The morphological differences between the river and the basin induce no important differences either in primary production or in the part of autochthonous primary production in the total supply of organic matter; allow the development in the basin of a more abundant zooplankton community, which consumes a significant part of the total supply of phytoplanktonic material; induce an important sedimentation of particulate material, including phytoplankton; and reduce the bacterial activity in the water column. (Baker-IVI)
W85-05634

CHANGES IN THE QUALITY OF RIVER OISE WATER DURING RETENTION IN THE STORAGE BASIN AT MERY (FRANCE) (EVOLUTION DE LA QUALITE DE LA RIVIERE OISE LORS DE SA RETENTION DANS LE BASSIN DE 'STORAGE' DE MERY (FRANCE)),
Universite Libre de Bruxelles (Belgium). Lab. d'Oceanographie.
G. Billen, C. Cavelier, S. Dessery, C. Lancelot, and M. Meybeck.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, P 1510-1515, December, 1984. 8 Fig, 1 Tab, 6 Ref.

Descriptors: *Storage reservoirs, *Water quality, *Oise, *France, Retention time, Water supply, Destratification, Suspended solids, Sedimentation, Flow discharge.

The storage basin of Mery-sur-Oise provides Oise water to a water treatment works which serves 500,000 inhabitants. The basin retains the water for a period of 4 days. The volume is 400,000 cu m, the maximum depth is 9 m and the surface area is 4.5 ha. The function of the reservoir is three-fold: smoothing out the short term variations in the quality of the water from the Oise; providing a reserve of 2 to 3 days water in case of pollution of the river, and amelioration of the quality of the water before treatment. Because of its very short residence time and the daily destratification caused by its exploitation, the reservoir of Mery-sur-Oise is affected mainly by the materials in suspension in the water. The reservoir acts as an arm of the Oise with a very slow flow and which is fed with water daily. The strength of the sedimentation and the internal development of sediments confirms the lacustrine character in the absence of stratification, and the importance of the allochthonous material for the organic carbon budget is another fluviatile characteristic. The reservoir has not attained equilibrium after three years of operation. (Moore-IVI)
W85-05635

DEPENDENCE OF PHYTOPLANKTON ON ZOOPLANKTON IN A MAN-MADE LAKE,
Politechnika Slaska, Gliwice (Poland).
B. Grzybowska, and B. Wodzinska.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1517-1520, December, 1984. 2 Fig, 3 Tab, 3 Ref.

Descriptors: *Reservoirs, *Phytoplankton, *Zooplankton, Primary productivity, Eutrophication, Seasonal variation, Poland.

Phytoplankton and zooplankton were studied in a man-made lake polluted with municipal and industrial wastewaters and warm water from a steam power plant near Rybnik, Poland. This reservoir was filled in 1973. Microplankton measured during the four years produced blooms in February and March consisting of Asterionella formosa, sometimes with Fragilaria crotonensis. Autumn blooms appeared only twice. The nannoplankton during the whole year consisted of species of Cryptomonas, Trachelomonas, Scenedesmus, other Chlorococcales, Anabaena and other small algae in various proportions. A mass appearance was never found of any one algal species. The percentage of nannoplankton in the total phytoplankton was high except during the periods of microplankton blooms. The microplankton did not appear to be a food for filter-feeding zooplankton. The nannoplankton biomass fluctuated during the year within the range 0.1-1.3 mg/l. Large quantities of small algae appeared during the absence of filter feeding zooplankton. Increase of zooplankton may be correlated with decrease of the consumed nannoplankton. After the disappearance of the zooplankton, the nannoplankton again became important. A low stable value of nannoplankton biomass during the whole year is characteristic. This suggests a comparison to the uniform grazing of a meadow by a herd adapted quantitatively to the area of the meadow, where a fertility is expressed as an increment in herd size. (Baker-IVI)
W85-05636

APPLICABILITY OF THE OECD EUTROPHICATION MODELS TO SPANISH RESERVOIRS,
Centro de Estudios Hidrograficos, Madrid (Spain).
J. L. O. Casas, and R. P. Martinez.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1521-1535, December, 1984. 7 Fig, 3 Tab, 7 Ref.

Descriptors: *Reservoirs, *Eutrophication, *Model studies, *Spain, Nutrients, Phosphorus, Chlorophyll, Mathematical equations.

Seventeen reservoirs in Spain were monitored for a maximum period of three years, both within the receiving waterbodies and at the major tributaries. The normalized P loading term provides a fairly good approximation in a large number of Spanish reservoirs providing a significant statistical correlation coefficient. The empirical relationship between average summer chlorophyll concentration and average annual lake P concentration, either measured or deduced from the normalized P load does not allow for a satisfactory fit by means of a potential function. The regression equations resulting from the OECD waterbodies are substantially different from those obtained from the Spanish reservoirs. There appears to be a fairly good correlation between mean summer Secchi disc depth and the flushing corrected inflow P loading. A similar good correlation is provided by mean summer Secchi depth and mean annual in lake P concentration. The relationships obtained are close to those found for the OECD waterbodies, particularly to the equations found for the Shallow Lakes and Reservoir Group. The hypolimnetic oxygen depletion rate does not appear to show any relationship with annual total P loading in spite of

taking into account the water balance within the hypolimnion. This may be due to errors of calculation because of scarcity of data, and potentially strong chemical oxygen demand by sediments in some of the reservoirs. Those reservoirs undertaking a drastic increase of hydraulic residence time because of severely dry periods do not fit well the above relationships during such periods. (Baker-IVI)
W85-05637

PHOSPHORUS COMPOUNDS IN THE SEDIMENT OF THE SAU RESERVOIR (BARCELONA, NE SPAIN) THROUGHOUT ITS TWENTY-YEAR EXISTENCE,
Barcelona Univ. (Spain). Dept. de Ecologia.
J. Armengol, M. Crespo, and J. A. Morgui.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1536-1540, December, 1984. 3 Fig, 2 Tab, 11 Ref.

Descriptors: *Reservoirs, *Sau Reservoir, *Ter River, *Spain, *Phosphorus, Diagenesis, Erosion, Sedimentation, Organic compounds, Apatite, Rainfall.

The reservoir of Sau, located on the Ter River, was filled for the first time in the autumn of 1963. It has been studied limnologically on a monthly basis since 1963. The concentration of the three groups of P compounds (organic, apatite and inorganic non-apatite) was determined at the different levels of the sediment in the reservoir and their relationship with the different stages in the evolution of the reservoir was investigated. The mean concentration of the whole column is 35.02 micro-g at P of sediment. This represents an abundance by weight of 1.08% with oscillations from 1.47% to 0.68%. The sediments are of recent deposition. The non-apatite is the largest fraction, 35.37%, suggesting that the process of diagenesis has not been very important. Apatite is the P compound next in abundance at 32.12%. Finally, organic P is found in the smallest concentration, 14.5% and at the same time has the largest coefficient of variation, 38.29%, and a tendency to decrease as one goes deeper from the surface of the sediment. Apatite may come from erosion and not from diagenesis. Accepting this relationship between the apatite maxima and the periods of greater water flow in the Ter basin, the sedimentation rate can be estimated as having fluctuated between 3-4.5 cm in years of heavy rainfall and less than 1.5 cm in dry years. (Baker-IVI)
W85-05638

COMPOSITION AND DYNAMICS OF PHYTOPLANKTON IN THE CUBER RESERVOIR, SPAIN,
Palma de Mallorca Univ. (Spain). Facultad de Ciencias.
G. Moya, and G. Ramon.
Verhandlung Internationale Vereinigung Limnologie Vol. 22, No. 3, p 1541-1545, December, 1984. 4 Fig, 1 Tab, 17 Ref.

Descriptors: *Phytoplankton, *Population dynamics, *Reservoirs, *Cuber Reservoir, *Spain, Biological succession, Algae, Nutrients, Mixing, Chlorophyll a, Species composition.

Phytoplankton composition, dynamics and physiological characteristics were measured in the Cuber Reservoir. Observations suggest three principal periods in the phytoplankton succession. The first period of the succession comprises the phases I and II. The I group is distinguished by the presence of persistent species Cryptomonas spp. and Rhodomonas spp. as well as many Chrysophyceae and Oscillatoria rubescens. This phase represents the initial phase of the succession with the water completely mixed and an important amount of nutrients in the surface layers. The second period corresponds to the group III and is represented by the abundance of Chrysophyceae, the presence of the Dinophyceae Ceratium hirundinella, the persistence of different populations of Cryptophyceae and the accumulation of Oscillatoria rubescens at the depth. The third period of the succession returns everything to the initial conditions. The pattern of succession proposed for the Cuber reservoir is similar to that proposed for freshwater ecosystems. In spring they have all the characteristics of eutrophic lakes, with green and blue green algae, very high phytoplankton density and much chlorophyll a. Later, the reservoir shows a decrease in the number of cells and chlorophyll a, and the specific diversity increases: typical features of an oligotrophic lake. (Baker-IVI)
W85-05639

SEASONAL VARIATIONS IN THE VERTICAL DISTRIBUTION OF OSCILLATORIA RUBESCENS D.C. IN THE GORG BLAU RESERVOIR, SPAIN,
Palma de Mallorca Univ. (Spain). Facultad de Ciencias.
G. Ramon, and G. Moya.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1546-1549. December, 1984. 3 Fig, 15 Ref.

Descriptors: *Vertical distribution, *Seasonal variation, *Gorg Blau Reservoir, *Spain, *Plankton, Primary production, Population dynamics, Nitrates, Thermal stratification, Solar radiation.

Studies of the phytoplankton population density and dynamics in the Gorg Blau Reservoir show the predominance of Oscillatoria rubescens and the relationship of its seasonal variation with environmental factors. During autumn, winter and early spring the density of the Oscillatoria rubescens population increases and no differences in density through the water column can be detected. This period belongs to the interval of vertical mixing with comparable temperatures for the whole water column and a lessened underwater light intensity. During the second period the Oscillatoria rubescens population stratifies and decreases in the surface layers. This period belongs to the interval of thermal stratification in the reservoir which sees the development of an unstable thermocline at about 10-12 m and great underwater light intensity. These seasonal variations are due to the influence of light and the adaptation of the species to low illuminance conditions. Concentration of nitrate is the main determinant of growth and density of the population. (Baker-IVI)
W85-05640

LIMNOLOGY OF SUVIANA-BRASIMONE MAN-MADE LAKES: INFLUENCE OF PUMPED STORAGE OPERATIONS ON PHYSICAL, CHEMICAL AND BIOLOGICAL CHARACTERISTICS,
Bologna Univ. (Italy). Ist. di Zoologia.
For primary bibliographic entry see Field 6G.
W85-05641

OBSERVATIONS ON PHOSPHORUS DYNAMICS AND ORTHOPHOSPHATE TURNOVER IN A TROPICAL LAKE - PARAKRAMA SAMUDRA, SRI LANKA,
Vienna Univ. (Austria). Limnologische Lehrkanzel.
A. Gunatilaka.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1567-1571, December, 1984. 2 Fig, 2 Tab, 10 Ref.

Descriptors: *Limnology, *Reservoirs, *Parakrama Samudra Reservoir, *Sri Lanka, Nutrients, Temperature, Phosphates, Nitrogen, Diurnal variations, Cycling nutrients.

Parakrama Samudra in Sri Lanka is one of the larger reservoirs of an ancient irrigation system. The reservoir is located in the north central province at Polonnaruwa within the dry zone. The seasonal hydrological regime reflects the monsoonal cycle and the irrigation demands for rice cultivation in the area. The diurnal P dynamic patterns observed were very similar to the ones recorded during the high water situation in the early post-monsoonal period, but the diel changes were more distinct during the dry period. The soluble reactive P (SRP) concentration in the water column slightly increased with the increase of light intensity, but recorded a drop during the mid-day. In the late afternoon, the SRP level in the whole water column registered a slight increase. The peak values ranging from 17-26 micro g/l were observed at midnight. The soluble P (SP) level fluctuated between 10-38 micro-g/l. During the day SP indicated a gradual decrease in the water column and a minimum was recorded during the period of maximum SRP demand. The highest concentrations were noted during midnight. Phosphatase activity showed pronounced diel changes. Much of the dissolved P in lake water is colloidally bound and thus not readily available to the plankton. (Baker-IVI)
W85-05642

LIMNOLOGICAL ASPECTS OF PLANKTON VARIATION AND WATER CHARACTERISTICS OF A TROPICAL WEST AFRICAN RESERVOIR,
Jos Univ. (Nigeria). Dept. of Botany.
M. A. Khan, and C. Ejike.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1584-1589, December, 1984. 3 Fig, 14 Ref.

Descriptors: *Liberty Dam, *Nigeria, *Reservoirs, *Limnology, Plankton, Phytoplankton, Population dynamics, Monsoons, Seasonal variation, Transparency, Algae, Primary productivity.

The Liberty Dam is situated within Jos biotite granite area, which is a cooler upland site in Nigeria. The limnology of the water body was influenced by dynamic environmental factors. The rainy season was characterized by low records of Secchi depth, which corroborated with high vertical extinction coefficients. Poor ionic composition influenced among other factors by insoluble nature of granite in the catchment, fits the water body in Class I series of Talling and Talling African lakes. Planktonic microflora constituted principal plant life of the reservoir and well established macrophytic vegetation was lacking. The phytoplankton community was dominated by Chlorophyceae (44%) followed by Bacillariophyceae (39%) and Dinophyceae (15%). Staurstrum and Cosmarium, numerically abundant with high species diversity, were important desmid elements. Synedra was a common diatom. Peridinium, the only dinoflagellate identified, showed typical upsurge in early rainy season. Phytoplankton photosynthesis showed distinct seasonality with higher rates obtained for the rainy season corresponding to low water transparency and high plankton biomass. Seasonal variation of phytoplankton productivity approximated pattern A group of Melack's African lakes. Phytoplankton composition, abundance, and productivity rates are suggestive of oligo mesotrophic status for the ecosystem. (Baker-IVI)
W85-05643

PHYTOPLANKTON GRADIENTS DURING THE RAINY SEASON IN LAKE KARIBA,
Zimbabwe Univ., Harare. Lake Kariba Research Station.
L. Ramberg.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1950-1953, December, 1984. 2 Fig, 9 Ref.

Descriptors: *Lake Kariba, *Zambia, *Zimbabwe, *Phytoplankton, *Monsoons, Sediment transport, Plumes, Turbidity, Population dynamics, Silt, Biomass, Seasonal variation, Rainfall, Spatial distribution, Temporal distribution.

The total phytoplankton biomass in Lake Kariba, which lies between Zambia and Zimbabwe, has a grand mean of 290 mg/cu m and a more irregular distribution both in time and space than usually found in temperate lakes. In December the biomass varied between 690 and 0. Such low values were usually correlated to a high content of silt in the water. During the rainy season the rivers transport large amounts of silt into the lake visible as plumes several kilometers from the outlet and causing a general decrease in the euphotic depth to about 5 m in Lake Kariba. Simultaneously the thermocline sinks from 10 m in the warm-rainy season to 30 m in the cool-dry season. The turbid river water may also explain the larger variations in plankton bio-

mass during the rainy season. The rivers respond very suddenly on rainfalls and decline as fast after the rains causing the river waters to enter the lake in distinct silty water packages. Typical for the phytoplankton community in Lake Kariba is that the mean temporal variation was small as well as the mean difference between sampling stations. The quantitative composition was comparatively stable with the same 15-20 species making up the biomass in all samples. The relations between the dominating species varied a lot in both space and time with resulting large variances in the total biomass. (Baker-IVI)
W85-05644

PHYTOPLANKTON PRODUCTIVITY IN A SHALLOW TURBID IMPOUNDMENT, WURAS DAM,
Orange Free State Univ., Bloemfontein (South Africa). Inst. of Environmental Sciences.
J. U. Grobbelaar.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1594-1601, December, 1984. 5 Fig, 2 Tab, 14 Ref.

Descriptors: *Phytoplankton, *Primary productivity, *Turbidity, *Reservoirs, *Wuras Dam, *South Africa, Turbidity, Light intensity, Phytoplankton, Suspended solids, Euphotic zone.

The turbid impoundment, Wuras Dam has a euphotic depth of between 0.3 and 1.3 m and the attenuation of light is caused mainly by large amounts of suspended inorganic particles. Primary productivity was measured over a two year period during intensive short term investigations. Several characteristics of primary productivity in a shallow turbid impoundment could be identified, which have a direct influence on the structure and functioning of the system. Phytoplankton productivity follows essentially the same pattern in turbid waters as in clear waters. The euphotic zone is merely compressed in turbid waters, which would necessitate experimental care, not to miss P-max. The shallow euphotic depth results in large aphotic:euphotic ratios. Losses due to dark metabolism will become progressively more pronounced as the mixed layer becomes deeper. This could result in considerable production losses. Indications of shade adaptation were found, where the specific activity and light utilization index of the phytoplankton increased with an increase in turbidity. Such adaptation would be most important, especially in systems such as Wuras Dam where the phytoplankton is responsible for the major input of organic carbon into the system. Small systems are also subject to pronounced variation over short periods of time. (Baker-IVI)
W85-05645

OLIGOMICTIC MAN-MADE LAKE IN SOUTHEASTERN BRAZIL,
Sao Paulo Univ. (Brazil). Dept. de Ecologia.
C. G. Froehlich, and M. S. Arcifa.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1620-1624, December, 1984. 7 Fig, 3 Ref.

Descriptors: *Brazil, *Paraibuna Reservoir, *Oligomictic lakes, Water circulation, Temperature effects, Dissolved oxygen, Conductivity, Stratification, Reservoirs, Dissolved oxygen.

The Paraibuna Reservoir (Brazil) is generally stably stratified with a main thermocline mostly between depths of 13 and 20 m. Bottom temperatures are stable, rising very slowly between circulation periods. They are lower in the Paraitinga basin. Circulation to the bottom, which is accompanied by a marked decrease in transparency due to resuspension of sediments, took place in 1979 and 1981, while it did not occur in the milder winter of 1980, and probably also in 1982, because in this year no resuspension of sediments was noted. At each circulation to the bottom, a sensible decrease in bottom temperatures took place. Considering that the reservoir is young there is clearly a trend for bottom temperatures to get colder at each strong winter, increasing the stability of the water column in the intervening years with milder winters. The trend is clearly toward longer periods of no holomixis. The dissolved oxygen isopleths show that during circulation to the bottom there is an increase in bottom dissolved oxygen values, while at intermediate depths the absence of oxygen may be maintained. The electrical conductivity isopleths show a progressive increase in conductivity with depth and with the duration of the stratification. In 1980 there was evidence of a downward migration of surface water during the winter, slightly lowered bottom temperatures in both basins, and in Paraitinga basin, a small lowering of conductivity and, in September, a very small amount of dissolved oxygen at the depth of 70 m. (Baker-IVI)
W85-05647

FURTHER STUDIES ON THE ZOOPLANKTON COMMUNITY OF A EUTROPHIC RESERVOIR IN SOUTHERN BRAZIL,
Inst. de Pesca, Agric. of Sao Paulo State, Brazil.
S. Sendacz, E. Kubo, and L. P. Fujiara.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1625-1630, December, 1984. 5 Fig, 1 Tab, 14 Ref.

Descriptors: *Water pollution effects, *Eutrophication, *Billings Reservoir, *Brazil, *Zooplankton, Dissolved oxygen, Chlorophyll, Reservoirs, Wastewater pollution, Transparency, Water quality, Copepods.

Billings Reservoir is located near the city of Sao Paulo, Brazil and receives a great part of its domestic and industrial wastes. Water samples were taken from the reservoir at monthly intervals, from April 1981 to March 1982 at one station located 1 km approximately from the dam, with a mean depth of 9 m. As the dam constructed to isolate this branch of the reservoir is rather new, completed in December of 1981, some changes in the physical, chemical and biological characteristics of the water were noted. Secchi disc transparency values have increased. The median transparency in the dry season increased from 1.10 m in 1978 to 1.55 m in 1981. A slight decrease in the chlorophyll a content was also noted and in the standing stock of zooplankton. These finding may indicate modification in the ecosystem, since an increase in those parameters serves as an evidence of eutrophication. No major differences were noted both concerning the zooplankton numbers and the relative abundance of the zooplanktonic groups. The only noticeable feature is the occurrence of calanoid copepods, although in few numbers, which were registered for the first time in this reservoir. (Baker-IVI)
W85-05648

CONTRIBUTION OF TWO AQUATIC MACROPHYTES TO THE NUTRIENT BUDGET OF LOBO RESERVOIR, SAO PAULO, BRAZIL,
Universidade Federal de Sao Carlos (Brazil). Lab. of Limnology.
R. Barbieri, F. A. Esteves, and J. W. Reid.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1631-1635, December, 1984. 4 Tab, 8 Ref.

Descriptors: *Nutrients, *Lobo Reservoir, *Brazil, *Macrophytes, Aquatic plants, Water level, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Proteins, Cycling nutrients.

The relative contribution of some nutrients and compounds by the dominant macrophyte species Nymphoides indica and Pontederia cordata was studied during normal and dry periods in the littoral zone of the tropical reservoir Represa do Lobo, State of Sao Paulo, Brazil. During the study period. N. indica covered 27.3 ha or 4.0% of the reservoir and P. cordata covered 3.6 ha or 0.5%. In August of 1980 the water level fell 2 m due to a break in the dam, resulting in the death of most aquatic macrophytes. From September onwards the leaf blades and petioles of individuals of N. indica showed a definite decrease in diameter and size. New individuals growing in the littoral zone differed in the concentration of most substances analyzed from those existing before the break. N content of N. indica varied from a mean of 1.6% before to 2.3% afterwards. N content in P. cordata increased only slightly over the same period. Protein content showed the same tendencies in each species. Standing stocks of all elements and compounds analyzed underwent substantial reduction during the low water period in each species. Standing stocks of the nutrients N and P in N. indica were 6 and 13 times higher, respectively, than in the water of the littoral and pelagic zones. K, Ca, Mg, and protein standing stocks were proportionately greater in P. cordata than in N. indica, but the contribution of the latter species to the reservoir was substantially greater due to the larger area inhabited by it. Thus, N. indica is the most important of the aquatic macrophyte species in the cycling of organic material and nutrients, especially N and P, in this reservoir. (Baker-IVI)
W85-05649

SOME LIMNOLOGICAL CHARACTERISTICS OF A TEMPERATE FOREST POND,
Vrije Univ., Brussels (Belgium). Lab. voor Algemene Plantkunde en Natuurbeheer.
L. Deronde, T. Lomema, I. van Elslande, D. Van de Gucht, and H. Borgoo.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1663-1671, December, 1984. 5 Fig, 21 Ref.

Descriptors: *Ponds, *Forest watershed, *Litter, *Decomposition, Limnology, Potassium, Humic acids, Phytoplankton, Algae, Zooplankton, Humic compounds, Leaching, Potassium.

Data are summarized from limnological observations made mainly during the period 1974-1978 in a pond greatly influenced by its forest surrounding, by the yearly litter fall and by litter decomposition. The pond examined is the first in a series of four ponds receiving water from a brooklet originating in a spring area about 100 m above. The water temperature varied from 0 to 24.2 C. Diurnal variations of the surface temperature could reach 4 C. Secchi disk transparency in the pond was found equivalent to the depth of 25% light penetration. Water pH is mostly between 7 and 8. Oxygen depletion near the bottom was occasionally observed in summer. A total of 202 algal taxa were identified in the plankton of the pond. The winter plankton consists mainly of Cryptomonas and Trachelonmonas. In spring, Peridinium and the Chrysophyceae develop. The diatoms reach their maximum in March or April; the Chlorococcales somewhat later. The total volume of the phytoplankton showed distinct maximum values in July. The species composition of the zooplankon was followed from 22 July 1974 to 11 July 1975 with 19 species of Rotifera, 9 of Cladocera and 7 of Copepoda being identified. The zooplankton showed peaks numerically dominated by Rotifera. High zooplankton biomass values were found only in summer, from June to September. Total annual litterfall falling into the pond was estimated at 1000 kg dry weight in 1976-77, 880 kg in 1977-78, and 730 kg in 1978-79. These figures correspond to an average fall of 0.35-0.46 kg/sq m. This litterfall consists mainly of beech leaves. Leaching of the major cations from the leaves is particularly rapid for potassium ions which is reflected in a distinct peak in potassium concentration occurring yearly after leaf fall. This litterfall of forest origin represents an important input of POM and DOM to the pond, and results in its non negligible humic content. Three fractions of soluble humic compounds were isolated. (Baker-IVI)
W85-05651

LIMNOLOGICAL CHARACTERISTICS OF SOME SMALL EUTROPHICATED LATE-GLACIAL POOLS,
Department of Public Works, Leeuwarden (Netherlands).
T. H. L. Claassen.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1681-1686, December, 1984. 3 Tab, 10 Ref.

Descriptors: *Pools, *Friesland, *Netherlands, *Limnology, *Eutrophication, Water quality, Chloride, Conductivity, Acidity, Oxygen, Invertebrates, Cations, Anions.

Many pools in the eastern part of Friesland are regarded as valuable elements in the landscape. Nowadays most pools are surrounded by grassland. A few remnants of pingos are still situated in moorland. Five pingo-remnants were selected for a closer investigation. The chloride concentration is roughly the same in the pools. The annual fluctuation was greatest in the most shallow pool in which the chloride concentration varied from 12 mg Cl(-)/l in February to 101 mg Cl(-)/l in June. The mean cation concentration showed the following order of quantitative importance: Ca(++) > Na(+) > Mg(++) > K(+). The sequence for the anions was HCO3(-) > Cl(-) > SO4(--). The sampled pools had a well developed littoral overgrowth. The macroinvertebrates mainly consisted of Diptera, both regarding the number of taxa and the number of individuals, ranging from 36 to 51% and from 41 to 89%, respectively. (Baker-IVI)
W85-05652

PRELIMINARY GROUPING OF THE SMALL EPICONTINENTAL WATER BODIES IN SPAIN AND DISTRIBUTION OF CRUSTACEA AND CHAROPHYTA,
Barcelona Univ. (Spain). Dept. de Ecologia.
M. Alonso, and M. Comelles.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1699-1703, December, 1984. 1 Tab, 10 Ref.

Descriptors: *Spain, *Limnology, *Crustacea, *Charophyta, Climate, Topography, Turbidity, Lakes, Ponds, Salinity, Geology, Population dynamics.

Some 500 lakes and ponds throughout Spain were studied. The environmental parameters examined included periodicity, mineralization and turbidity due to clay. These are conditioned by the climate, the depth of the depressions, the nature of the substrate and the kind of drainage. Four groups of water bodies are recognized, and the frequency of appearance of the species corresponding to each one was calculated. The Iberian Peninsula is a very suitable area for regional limnlogical studies. The N and NW silicious and wet region contain abundant clean fresh water in which ubiquitous and cosmpolitan species can be found with species of Central European distribution being common. Communities of athalasohaline, muddy and mineralized waters occur in the semiarid landscape. Arctodiaptomus wierzejskii and Daphnia magna are characteristics of clean, mineralized, but not saline waters. The charophytes constitute a group widely distributed in continental waters, with species of varied ecology. (Baker-IVI)
W85-05653

PATTERNS OF DIEL OXYGEN CHANGE IN PONDS OF TROPICAL INDIA,
Kansas State Univ., Manhattan. Div. of Biology.
G. R. Marzolf, and G. W. Saunders.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1722-1726, December, 1984. 3 Fig, 1 Ref.

Descriptors: *Dissolved oxygen, *India, *Ponds, *Diel variation, Oxygen, Respiration, Diurnal variation, Productivity, Water temperature, Photosynthesis, Macrophytes, Biomass, Carbon.

Diel changes in oxygen concentration were measured in a few water bodies of tropical India and are presented as an indication of the intensity of production and respiration processes and the diverse conditions under which high productivity occurs. All of the basins are shallow, on the order of 4 m deep. The basins are filled by the monsoon rains and the water evaporates during dry seasons, sometimes to dryness. The Microcystis Pond was the most productive of the three studied. The peak oxygen concentration was reached in the early afternoon at 1:30 PM, probably due to apparent cessation of photosynthesis due to nearly complete depletion of inorganic carbon from the water. The temperature of the pond water at the peak oxygen concentration on this day was 31 C, thus oxygen concentration at this time was about 376% of saturation. The diel changes in oxygen concentration in the Swamy Pond were smaller in magnitude, the increase started later because of the shadow cast by its deep walled basin, and the saturation, about 153%, was lower at the peak concentration. The time of peak concentration was 3:30 PM. The changes in oxygen concentration in Melakkal Lake waters were the lowest in magnitude and the peak concentrations were reached latest in the day. The difference was more likely due to differences in nutrient concentration, and macrophyte biomass than to the difference in light intensity. The vertical profile of dissolved oxygen changed through time in Microcystis Pond. The changes during the daylight hours are illustrated. The peak concentration was about 5 cm below the surface at 4 PM. This is probably due to carbon limitation in the surface layer and to diffusion than to photoinhibition of photosynthesis. Oxygen concentration a few centimeters from the bottom of the pond remained below 0.75 mg of oxygen/l, more than 10% saturated. Increases in oxygen concentration during the day were negligible at depths greater than 25 cm; a very shallow euphotic zone. (Baker-IVI)
W85-05654

TROPICAL AUSTRALIA, A DYNAMIC LIMNOLOGICAL ENVIRONMENT,
Tasmania Univ., Hobart (Australia). Dept. of Botany.
T. Walker, and P. Tyler.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22 No. 3, p 1727-1734, December, 1984. 4 Fig, 3 Tab, 17 Ref.

Descriptors: *Limnology, *Alligator River, *Arnhem Land, *Australia, Monsoons, Flood plains, Stratification, Billabongs, Acidity, Turbidity, Sodium, Magnesium, Carbonates, Sulfates, Light penetration, Primary productivity, Algal growth.

The Alligator Rivers and their tributaries rise on the sandstone plateau of Arnhem Land. The dominating climatic feature is the sharp distinction between wet season and the dry. Mean water temperature varies from about 24 to 32 C. The billibongs of the ARR (Alligator River Region) exhibit a continuum of stratification behavior, defying classification. At one end is Kulukuluku with several months of de facto stratification, at the other the shallow backflow billabongs where, at best, thermal gradients are ephemeral. During the wet season the billabongs are all inundated and flushed, to enter the dry season with a common water which is dilute, near neutral and dominated by Na/MgHCO3. Nutrient levels are at their lowest, but on a world scale total phosphorus levels are high and the billabongs are meso- to hyper-eutrophic. By the end of the dry season the three main groups can be distinguished by the nature and extent of ionic change they have undergone. Of the three parameters likely to affect light conditions, gilvin (organic color), chlorophyll and turbidity, the last one is overwhelmingly dominant, exerting its influence through adsorption rather than scattering. About 700 taxa of freshwater algae, mostly desmids, have been recognized with obvious tropical affinities. Light and nutrients commonly control primary productivity. (Baker-IVI)
W85-05655

STREAM ECOSYSTEM THEORY,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 2E.
W85-05662

UPTAKE OF DISSOLVED ORGANIC CARBON IN MOUNTAIN STREAMS,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
C. N. Dahm.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1842-1846, December, 1984. 2 Fig, 1 Tab, 19 Ref. NSF grants DEB 7923444 and DEB 8112455.

Descriptors: *Streams, *Organic carbon, *Dissolved solids, *Mountain streams, Oregon, Organic matter, Carbon radioisotopes, Stream order, Riparian vegetation, Forest watersheds.

To study the rates and mechanisms for conversion or transfer within the labile subfractions of organic matter in streams, it is often necessary to devise experimental procedures which focus upon processes affecting known labile components of this material. Three factors potentially affecting the rate and efficiency of uptake of dissolved organic carbon (DOC) in mountain streams are examined. They include the source of the DOC, the order of stream, and the vegetational structure of the riparian zone. The study streams were located in forested watersheds on the Coast and Cascade Ranges of western Oregon. Three sources of C-14 labeled DOC were tested for the rate and efficiency of uptake using first and third order stream sediment and water. The three sources included an algal lysate, alder leaf leachate, and Douglas fir needle leachate. The rate of C-14 uptake was clearly dependent upon the source of the soluble material. The overall conclusion that DOC uptake is more rapid in smaller order sreams must be made cautiously. It is possible that the more direct linkage between the watershed and small streams results in a microbial population better able to utilize allochthonous sources of DOC such as alder leaves. Differences in sediment characteristics used in the experiment may also explain these trends. (Baker-IVI)
W85-05665

FACTORS RELATED TO ALGAL BIOMASS IN MISSOURI OZARK STREAMS,
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
J. R. Jones, M. M. Smart, and J. N. Burroughs.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1867-1875, December, 1984. 1 Fig, 3 Tab, 22 Ref.

Descriptors: *Missouri, *Mountain streams, *Algal growth, *Biomass, Eutrophication, Streams, Nutrients, Periphyton, Land use, Chlorophyll.

Both physical characteristics and nutrient concentration determine suspended algal biomass in Missouri Ozark streams. While it is likely that both physical characteristics and nutrients have a continual effect on stream algal biomass, there is probably a shift in their relative importance over time. Flow is a major factor determining both benthic and suspended values. During periods of high flow, frictional shear stress removed periphyton from the streambed. These cells were subsequently concentrated during downstream transport so that the area of watershed upstream for the sampling point explained a significant portion of the variance in suspended chlorophyll a concentrations among the 12 sites. Nutrients were not limiting during high flow. In contrast, during the lower flows of summer, all differences in suspended algal chlorophyll were significantly correlated with nutrient concentrations. Differences in benthic chlorophyll among sites did not show these nutrient relations. Averaged over time, an increase in nutrient concentration may stimulate growth and cell loss from the periphyton. Nutrient concentrations in Ozark streams are highly correlated with urban areas and agricultural practices. As these landuse practices expand in the region suspended chlorophyll a values will increase to a point where nutrients will become less important in limiting algal denisities and physical characeritics will be the major factors determining algal chlorophyll in these settings. (Baker-IVI)
W85-05667

SIZE DISTRIBUTION AND LIGNIN CONTENT OF FINE PARTICULATE ORGANIC MATTER (FPOM) FROM MICROBIALLY PROCESSED LEAVES IN AN ARTIFICIAL STREAM,
Alabama Univ. in Birmingham. Dept. of Biology.
G. M. Ward.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1893-1898, December, 1984. 2 Fig, 2 Tab, 14 Ref. NSF grant DEB-8112455.

Descriptors: *Streams, *Leaf litter, *Organic matter, *Particulate matter, *Lignin, Decomposing organic matter, Leaves, Microbial degradation, Litter, Seasonal variation, Aquatic insects.

For a period of 21 weeks leaves of pignut hickory were incubated in a recirculating, plexiglass chamber containing 70 L of streamwater held at 10 C. The study was designed to estimate from these lab experiments the amount of leaf litter which could be expected to enter the fine particular organic matter (FPOM) pool during microbial processing; to document the particle size distribution of microbially produced FPOM; and to determine the content of lignin present in microbially produced FPOM. After 142 days of processing, only 13% of the original leaf material remained, and consisted mainly of veins and veinlets. Leaching losses accounted for 21% of the original dry weight, coarse particulate organic matter (CPOM) fragmentation 4%, FPOM sloughing 33%, and mineralization 29%. Production of FPOM was slow during the first seven weeks, as was total weight loss. Weight loss rates increased greatly in the latter stages of processing when most of the FPOM was released. Peak FPOM release occurred during the 13th week of incubation, while relatively large amounts of release occurred between day 80-101, when 50% of all FPOM accumulated. The majority of FPOM released was < 53 micro-m > 0.45 micro-m in diameter. Particles > 0.25 mm diameter contained a higher proportion of lignin than did leaves, while particles < 0.125 mm contained much less lignin than either leaves or the larger particles. Smaller FPOM contained much less lignin, and consisted mainly of macerated mesophyll cells. Because of the seasonal nature of leaf fall, the timing of mesophyll derived inputs of FPOM should also be pulsed. It is possible that if after months of microbial processing native FPOM may become too refractory to support insect development. If so, these fall inputs of FPOM from leaf liter represent an annual renewal of high quality detritus, necessary, in part, for completion of some insect life cycles. (Baker-IVI)
W85-05669

PHOSPHORUS UPTAKE BY DECOMPOSING LEAF DETRITUS: EFFECT OF MICROBIAL BIOMASS AND ACTIVITY,

Oak Ridge National Lab., TN. Environmental Sciences Div.
P. J. Mulholland, J. W. Elwood, J. D. Newbold, J. R. Webster, and L. A. Ferren.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1899-1905, December, 1984. 1 Fig, 2 Tab, 23 Ref.

Descriptors: *Phosphorus, *Absorption, *Leaves, *Microbial degradation, Biomass, Decomposition, Organic matter, Nutrients, Detritus, Organic carbon.

Temporal patterns of P uptake were examined during the early stages of leaf decomposition in streams. Patterns of P uptake were compared to patterns of other measurements of microbial activity to identify the effect of microbial succession or conditioning of leaves on P uptake. Results suggest that P utilization, and hence uptake length of P in streams, may follow a predictable pattern after input of autumn-shed leaves. As the microflora develops on leaf detritus, the uptake length of P should decrease, reaching a minimum as early as 3 weeks after peak leaf fall. Thereafter, if new inputs of leaves are not great, uptake length should increase. Consequently, in addition to the quantity of leaf detritus, the level of microbial activity on leaves should influence stream P utilization and uptake length. The results also imply that the quality of organic carbon substrate, or quantity of readily utilizable organic carbon, may at times limit microbial productivity and nutrient uptake in streams. Alternatively, if lower microbial activity is the result of self-limitation at high microbial biomass, shredder organisms may modify the temporal pattern somewhat by cropping microbial biomass, thus maintaining high rates of microbial metabolism for longer periods. (Baker-IVI)
W85-05670

TEMPORAL CHANGES IN NUMBERS OF SUSPENDED BACTERIA IN A SMALL WOODLAND STREAM,

Center for Energy and Environment Research, San Juan, PR.
W. H. McDowell.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1920-1925, December, 1984. 5 Fig, 20 Ref.

Descriptors: *Bear Brook, *New Hampshire, *Bacteria, *Streams, *Temporal distribution, Energy, Nutrients, Rivers, Plankton, Stream discharge, Organic carbon, Dissolved solids.

Temporal changes in total numbers of bacteria in the water column of Bear Brook, New Hampshire were examined. Concentrations of planktonic bacteria ranged from 26,900 to 889,000/ml with highest values observed during spring runoff and lowest values during summer. No seasonal trends were noted. Bacterial concentrations less than 100,000 were found in all seasons, and concentrations rose consistently during periods of increasing discharge in all seasons. Bacteria were commonly small cocci and rods estimated to be 0.2 to 0.8 micro-m in size. Chains or actively growing colonies were found infrequently. Bacterial concentrations peaked at or before peak discharge during spates. Bacterial concentrations showed a linear relationship with stream discharge when both were normalized using a logarithmic transformation. The logarithm of bacterial concentration is also linearly related to dissolved organic carbon (DOC) concentration. Dissolved organic carbon concentration and the logarithm of discharge together accounted for 61% of the variance in bacterial concentration. DOC concentration accounted for 54% of total variance, with an additional 7% explained by stream discharge. (Baker-IVI)
W85-05672

DETRITUS DECOMPOSITION IN ENDOGENOUS AND EXOGENOUS RIVERS OF A TROPICAL WETLAND,

Lund Univ. (Sweden). Limnological Inst.
R. C. Petersen.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1926-1931, December, 1984. 6 Tab, 13 Ref.

Descriptors: *Riparian vegetation, *Wetlands, *Detritus, *Decomposition, Rivers, Tropical regions, Decomposing organic matter, Macroinvertebrates, Microbial degradation, Aquatic plants, Invertebrates.

A study of the decomposition process was undertaken in several of the streams and rivers in order to increase the understanding of the ecology of the wetlands. The Lower Morass of the Black River is a freshwater wetland area in western Jamaica comprising an area of about 68 sq km. The major habitat is a sedge marsh dominated by sawgrass and to a lesser extent by other Cyperaceae. The riparian vegetation is dominated by Typha domingensis, Thalia geniculata, Alpina allughas and the fern Acrostichum sp. The overall rate of decomposition, microbial consumption and the effect of macroinvertebrates was greater in streams coming from outside the wetland compared to the streams which arise within the system. Macroinvertebrates were shown to be more responsive to the between system differences. (Baker-IVI)
W85-05673

CLASSIFICATION OF SITES ON BRITISH RIVERS USING MACROINVERTEBRATES,

Freshwater Biological Association, River Laboratory, Dorset, England.
J. F. Wright, P. D. Armitage, M. T. Furse, and D. Moss.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1939-1943, December, 1984. 1 Fig, 3 Tab, 8 Ref.

Descriptors: *England, *Scotland, *Wales, *Rivers, *Invertebrates, Geology, Topography, Sediments, Silt, Clay, Pebbles, Habitats, Population dynamics, Species diversity, Substrates.

The species richness of the 268 sites used in the classification of rivers in England, Scotland and Wales was examined in relation to substratum and distance of site from source. All available habitat types at each site were sampled with a pond-net for a period of three minutes in the spring, summer and autumn. Sites with a coarse substratum (cobbles, pebbles and gravel) are better represented than sites where sand or silt predominate. At sites close to the source (0-5 km) the number of taxa recorded did not exceed 100. Further downstream about 10% of the site exceeded this value and the number of taxa increases downstream to about 40 km after which there is a slight decrease. Sites with a coarse substratum dominated by cobbles or pebbles were less species-rich than sites where gravel was predominant, but on sandy and silty substrata no consistent pattern emerged. (Baker-IVI)
W85-05674

INFLUENCE OF CURRENT VELOCITY ON PERIPHYTON DISTRIBUTION AND SUCCESSION IN A NORWEGIAN SOFT WATER RIVER,

Norsk Inst. for Vannforskning, Oslo.
E.-A. Lindstrom, and T. S. Traaen.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1965-1972, December, 1984. 6 Fig, 3 Tab, 21 Ref.

Descriptors: *Rivers, *Velocity, *Norway, *Periphyton, *Succession, Water quality, Monitoring, Algae, Floods.

Current velocity must be considerd when sampling periphyton for water monitoring purposes. Current velocity influences the patchy distribution at a particular time and even the growth period of particular species. Water chemistry may alter the velocity range of a species. Of the three velocity ranges investigated, the intermediate one (about 50 cm/sec) seems most suitable. At this velocity, the highest number of the characteristic species and few occasional species appeared. More of the occasional species were present at low current velocities. Furthermore, algae growing at low velocity were extremely susceptible to sloughing during floods. In the high velocity range, species richness was reduced due to mechanical stress. (Baker-IVI)
W85-05677

FUNCTIONAL ASPECTS OF A LAKE OUTLET VERSUS A SPRINGFED STREAM ECOSYSTEM,

Lund Univ. (Sweden). Dept. of Animal Ecology.
B. Malmqvist, and C. Bronmark.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1992-1996, December, 1984. 2 Fig, 13 Ref.

Descriptors: *Ecosystems, *Streams, *Lake outlets, *Springfed streams, Streamflow, Temperature, Carbon, Trophic level, Springs, Lakes, Aquatic animals, Benthos, Seasonal variation.

Temperature, water flow, carbon transport, and the trophic guilds of the benthos are compared for two ecosystems, a lake outflow draining a small eutrophic lake and a springfed stream. Summer temperature was higher in the lake outlet than in the stream. In winter the situation was reversed with higher temperatures in the springfed stream. The lake outlet had a higher number of degree days and the annual mean temperature was 1.7 C higher and in summer the average temperature exceeded that of the springfed stream by about 5 C. The lake was ice-covered between 7 January and 7 April 1980. Neither the lake outlet nor the stream was ice covered during the study period. The water level showed a winter peak in both systems. There was a large difference between high and low water in the lake outlet and the duration of the winter high water was longer. The lake outlet had one winter peak and one summer peak in dissolved organic carbon concentration, while the stream had only a summer maximum. No correlations between carbon parameters and discharge were statistically significant. Benthic organic matter in the top 3 cm was much higher in the lake outlet. The lake outlet always had a high number of scrapers. In quantitative terms, biomass was considerably higher in the lake outlet, to a large extent due to the mass of mussels. The percentage of holoaquatic animals was at all dates higher in the lake outlet than in the springfed stream. By weight holoaquatic animals averaged

>97% in the lake outlet because of high mollusk weights. (Baker-IVI)
W85-05680

SEASONAL DYNAMICS OF WATER MOVEMENTS AND OF SUSPENDED MATTER IN A LARGE RIVER (DYNAMIQUE SAISONNIERE DES MOUVEMENTS DE L'EAU ET DES PARTICLES EN SUSPENSION DANS UN FLEUVE),
Lyon-1 Univ., Villeurbanne (France). Section of Freshwater Ecology.
For primary bibliographic entry see Field 2E.
W85-05681

STABILITY AND CHANGES OF BIOMASS OF EMERGING INSECTS AND THEIR POSSIBLE CAUSES,
Max-Planck-Inst. fuer Limnologie, Schlitz (Germany, F.R.). Limnologische Flussstation.
P. Zwick.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22. No. 3, p 2037-2041, December, 1984. 2 Fig, 15 Ref.

Descriptors: *Breitenbach, *Germany (Federal Republic), *Biomass, *Aquatic insects, Population dynamics, Temperature effects, Thermal gradients, Species diversity.

In Breitenbach, Federal Republic of Germany there is a downstream increase of daily as well as annual temperature amplitudes on the 2 km stretch between a large spring entering the stream and its mouth into the Fulda River. The importance of this thermal gradient for longitudinal zonation of Ephemeroptera, Plecoptera and Trichoptera is re-evaluated. Less species than previously suggested are actually affected. A regular upstream increase of abundance is observed only in 3 species, but these include 2 of the most important secondary producers of the stream community, which is dominated by oligo-stenothermal species. More species exhibit a downstream increase of abundance, but none of these more polyeurythermal ones is among the numerically important species in the stream. Distribution and abundance of most species in the stream are irregular and apparently determined by other factors such as substrate composition at the stream bottom. (Baker-IVI)
W85-05684

VEGETATION PATTERNS IN THE NORTH BLACK RIVER PEATLAND, NORTHERN MINNESOTA,
Minnesota Univ., Minneapolis. Limnological Research Center.
P. H. Glaser.
Canadian Journal of Botany, Vol. 61, p 2085-2104, 1983. 9 Fig, 4 Tab, 52 Ref. DOE contract DOE ACO1-80EV10414, NSF grant DEB-7922142.

Descriptors: *North Black River peatland, *Minnesota, *Vegetation, *Peatlands, Bogs, Fens, Wetlands, Topography, Water chemistry, Remote imagery, Ecological distribution.

Raised bogs and water tracks in the 193-sq km North Black River peatland in northern Minnesota were examined in relation to the vegetation, water chemistry, and surficial water movements as inferred from infrared aerial photographs, LANDSAT imagery, and orthophoto topographic maps. Two noda of bog vegetation were distinguished by the Braun-Blanquet system; both bog noda are associated with relatively dilute, acidic waters (pH range 3.9-4.1; Ca(2+) concentration range 0.6-1.6 mg/L; specific conductivity, K corr range 1.3-83 micro-S/cm). Rich-fen vegetation in contrast is more variable within this peatland and generally occurs in water tracks with a correspondingly wide range of pH (range 5.0-6.2), Ca(2+) concentration (range 3.6-30.4 mg/L), and K corr (range 31 to 182 micro-S/cm). Poor-fen vegetation was most distinguishable by the transitional nature of its vegetation and water chemistry with at least a few minerotrophic indicator species present in all cases and intermediate ranges in pH (3.7-5.2), Ca(2+) concentration (0.6-5.5 mg/L), and K corr (16-72 micro-S/cm). Bog and fen patterns in this peatland are consistently related to topographic features along the upland crest of each peatland watershed, indicating the topography controls the path of minerotrophic runoff draining onto the peatland, and thus creating zones with either enriched minerotrophic flow (in which water tracks develop) or stagnation zones (where bogs develop) on the peatland downslope. (Author's abstract)
W85-05685

ECOLOGY OF LAKE NAKURU; VI. SYNOPSIS OF PRODUCTION AND ENERGY FLOW,
Munich Univ. (Germany, F.R.). Zoologisches Inst.
E. Vareschi, and J. Jacobs.
Oecologia, Vol. 65, No. 3, p 412-424, Februry, 1985. 5 Fig, 66 Ref.

Descriptors: *Lake Nakuru, *Kenya, *Productivity, *Trophic level, Saline lakes, Alkaline lakes, Eutrophication, Algae, Rotifers, Flamingoes, Pelicans, Fish, Copepods, Aquatic insects, Biomass, Photosynthesis, Food chain.

Lake Nakuru in the Eastern Rift Valley of Kenya is an alkaline-saline lake. During a five year study, the lake had a bloom of Spirulina platensis that persisted at least two years, periods with low algal densities and various transitional phases with dramatic fluctuations of species composition and density. The bloom was characterized by a rich and almost unialgal bloom of the cyanophyte S. platensis minor, with a mean biomass of 3,500 kJ/cu m (20 kJ approximately = 1 g dry weight). Net photosynthetic rates were very high at depths with optimal light conditions (230 kJ/cu m/h), but algal self-shading made integrated rates modest (45 kJ/cu m/24 h) relative to the high biomass. Of the eight primary consumers only five species contributed significantly to the consumer biomass of 220 kJ/cu m: the flamingo Phoeniconaias minor, the cichlid fish Sarotherodon alcalicus grahami, the copepod Lovenula africana, the dipteran larva Leptochironomus deribae, and the rotifer Brachionus dimidiatus. Consumption rates were about 50% of net photosynthetic rates, production rates about 10%. Secondary consumers (90% being the pelican Pelecanus onocrotalus and the Greater Flamingo Phoenicopterus ruber) had a biomass of about 6.8 kJ/cu m. Pelicans consumed almost the whole fish production (7.5 metric tons wet weight/day). At low algal densities the lake had a more diverse algal population but a reduced mean biomass of 1,300 kJ/cu m and mean net photosynthetic rates of 12 kJ/cu m/24 h. Primary consumer species diversity and biomass were also reduced. Consumption rates sometimes exceeded primary production rates. Rotifers probably contributed about 50% to total consumption and about 75% to total secondary production. Transitional phases are characterized by rapidly changing abiotic and biotic conditions with algal breakdowns and sudden population peaks at all levels. Rotifers dominated secondary consumers, they contributed 25% to the total biomass 380 kJ/cu m, 90% to the total consumption rate of 290 kJ/cu m/d and 95% to the total production of 41 kJ/cu m/d. (Moore-IVI)
W85-05704

DISTRIBUTION OF FISH IN THE VIRGIN RIVER, A TRIBUTARY OF THE LOWER COLORADO RIVER,
Southern California Coastal Water Research Project Authority, Long Beach.
J. N. Cross.
Environmental Biology of Fishes, Vol. 12, No. 1, p 13-21, January, 1985. 4 Fig, 3 Tab, 49 Ref.

Descriptors: *Fish, *Spatial distribution, *Virgin River, LaVerkin Springs, Deserts, Exotic fish, Aquatic habitats, Reservoirs, River flow, Water quality.

Large perennial rivers that flow through climatic deserts are comparatively few in number and their ichthyofaunas are impoverished relative to rivers in more equable climates. The Virgin River, a major tributary of the lower Colorado River, contains a unique, though impoverished, native ichthyofauna (six species) that is largely intact despite the introduction of exotic fishes (13 species) and alterations of the river (loss of habitat, water diversion, and pollution). The climate over most of the Virgin River basin is arid to semiarid with mild winters, hot summers, and high evaporation rates. The longitudinal distribution pattern of the native species does not follow theoretical expectations of a downstream increase in species richness. In the Virgin River, there is an absolute increase of available habitat downstream, but flow variability does not decrease, and habitat heterogeneity does not increase. No fish were collected in the river where LaVerkin Springs emerge and for more than 1 km downstream. For the size of the basin (> 15,000 sq km), the native ichthyofauna is extremely depauperate. The river is well isolated from other drainage basins. Most of the exotic fish are not established in the river, but persist through repeated invasions from downstream reservoirs. The persistence of the native fish in the Virgin River is dependent on the maintenance of sufficient discharge and reasonable water quality. (Moore-IVI)
W85-05710

MODEL FOR RAPID GROWTH EVALUATION IN FISHES: THE CASE OF THE CYPRINIDS OF SOME LARGE FRENCH RIVERS,
Ecole Nationale Superieure Agronomique de Toulouse (France). Lab. d'Ichthyologie Appliquee.
J. Moreau, A. Belaud, F. Dauba, and A. Nelva.
Hydrobiologia, Vol. 120, No. 3, p 225-227, January, 1985. 2 Fig, 2 Tab, 5 Ref.

Descriptors: *Fish, *Growth, *Mathematical models, *France, Africa, Rivers, Reservoirs, Photoperiod, Water temperature, Life span, Climate.

Within a fish population, individual growth is assumed to be a continuous phenomenon when fitted to the equation of Von Bertalanffy. The relationship between mean maximum observed length (LMMO) and the Von Bertalanffy factors L sub OO and k was studied in 42 populations of cyprinids from the following French rivers and their associated artificial lakes: Ain, Allier, Dordogne, Garonne, Lot, Rhone, Saone, and Tarn. The populations studied seem to conform to the model developed for African fish. For the same value of LMMO, L sub OO is higher in France than in Africa, and k has a lower value. The high temperatures and photoperiod in African waters may incude a higher food producrtion. This causes an important initial growth rate, but such a fast growth, not observed in temperate waters, may also stimulate ageing and thus produce a shorter life span for the same value of k than in temperate climates. (Moore-IVI)
W85-05717

ALTO SINU HYDROELECTRIC PROJECT IN COLOMBIA: POSSIBLE CONSEQUENCES FOR THE ENVIRONMENT,
Rijksinstituut voor Natuurbeheer, Leersum (Netherlands).
P. Leentvaar.
Hydrobiologia, Vol. 120, No. 3, p 241-248, January, 1985. 4 Fig, 1 Tab, 3 Ref.

Descriptors: *Chemical properties, *Dam effects, *Alto Sinu, *Sinu River, *Colombia, Dam effects, Turbidity, Eutrophication, Reservoirs, Environmental effects, Suspended solids, Dissolved oxygen, Algae, Fish, Trees, Flooding, Water pollution.

There are plans to construct two reservoirs in the upper Sinu River in the area known as Alto Sinu in Western Colombia. As a result, about 600 su km of tropical rainforest will be inundated. As very little is known about the ecology of this area, an attempt is made to summarize the available information on the chemical composition of the water and biological life, especially fish, in the Sinu River system. The Sinu rises in the northern Andes and flows into the the Caribbean Sea. The concentration of chemicals in the water varies with the discharge in the wet and dry seasons. There is a considerable amount of suspended material in the water, and turbidity is high in some areas. The river is well oxygenated, and BOD is low. The upper Sinu is eutrophic, but development of algae or submerged vegetations is limited because of the high turbidity

and fast-flowing water. In the lower Sinu and the cienagas, the flow of water is slow and the growth of algae is favored. Coliforms are present in large numbers, indicating pollution. The swift flowing water and the turbidity of the water prevents the growth of plankton in the main stream. About 148 fish species have been observed in the river system. As a consequence of flow regulation by the Alto Sinu Project, water may not reach the cienga; the cienga may dry up in places. Fisheries and navigation will be hampered if trees remain underwater in the reservoir area after inundation. The increase in transparency of the water as a result of sedimentation in the reservoir will be counteracted by the development of algae in the stagnant water. The hypolimnion may produce low oxygen levels during stratification. (Moore-IVI)
W85-05718

IN SITU METHANE PRODUCTION FROM ACID PEAT IN PLANT COMMUNITIES WITH DIFFERENT MOISTURE REGIMENS IN A SUBARCTIC MIRE,
Sveriges Lantbruksuniversitet, Uppsala. Institutionen foer Mikrobiologi.
For primary bibliographic entry see Field 2K.
W85-05720

VERTICAL DISTRIBUTION OF PRIMARY PRODUCTION AND PHYTOPLANKTON IN TWO SMALL LAKES WITH DIFFERENT HUMUS CONCENTRATION IN SOUTHERN FINLAND,
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
L. Arvola.
Holarctic Ecology, Vol. 7, No. 4, p 390-398, December, 1984. 14 Fig, 4 Tab, 30 Ref.

Descriptors: *Vertical distribution, *Primary productivity, *Phytoplankton, *Humus, *Lakes, *Finland, Nitrogen, Phosphorus, Biomass, Chlorophyll a, Algae, Bacteria, Stratification.

Vertical distribution of primary production and phytoplankton was studied in a polyhumic brownwater lake and in an oligo-mesohumic lake. During summer both lakes were thermally, chemically and biologically stratified. In the brownwater lake primary production was restricted to the uppermost layer of 1-1.5 m of epilimnion. In the oligo-mesohumic lake noticeable primary production was detected down to depths of 2-3 m. The ice-free period primary production was about 20% higher in the oligo-mesohumic lake, though occasionally the surface production was 2-3 times higher in the brownwater lake. Epilimnetic total phosphorus and total nitrogen concentrations were higher in the brownwater lake, while nitrate-nitrite, ammonium and phosphate concentrations were very low in both lakes. Phytoplankton was confined to the uppermost productive layer in the brownwater lake. In the oligo-mesohumic lake phytoplankton was distributed more evenly, though the mean maximum biomass was at the depth of 3-4 m. Below the oxic water layer biomass decreased abruptly in both lakes. In the oligo-mesohumic lake chlorophyll concentration was extremely high (max. 230 mg chl a/cu m) in the anoxic hypolimnion, due to green sulfur bacteria. Flagellated chlorophytes and chrysophytes dominated in the brownwater lake; in spring Chlamydomonas species, followed by Mallomonas caudata. In the oligo-mesohumic lake small coccal green algae, such as Oocystis, Scenedesmus and Westella-like species, dominated in mid-summer, and chrysophytes and cryptomonads in autumn. (Author's abstract)
W85-05721

WATER QUALITY AND WATERSHED LAND USED OF JOHNSON SAUK TRAIL LAKE,
Illinois State Water Survey Div., Peoria. Water Quality Section.
For primary bibliographic entry see Field 6G.
W85-05722

DIATOMS OF THE SHATT AL-ARAB RIVER, IRAQ,
Basrah Univ. (Iraq). Marine Science Centre.
R. A. M. Hadi, A. A. Al-Saboonchi, and A. K. Yousuf Haroon.
Nova Hediwgia, Vol. 39, No. 3/4, p 513-557, 1984. 245 Fig, 32 Ref.

Descriptors: *Diatoms, *Shatt al-Arab, *Iraq, Distribution, Species composition, Algae, Habitats.

The Shatt al-Arab River is the most important river and only source of water supply in the arid surrounding region of southern Iraq. This contribution is a part of an extensive survey to study the species composition, the distribution pattern of algal flora and to assess the effect of pollution, mainly organic, on the environment and algal populations in the Shatt al-Arab River and some of its canals. A 30 km stretch of the Shatt al-Arab River, from its beginning near Garmat Ali in the north to Abu al-Khasib in the south was chosen for study. Diatoms of the Shatt al-Arab River were collected monthly from April 1982 to June 1983 from different habitats (planktonic, epiphytic, epilithic and epipelic). A total of 116 taxa have been recorded, of which 22 taxa were new records for Iraq. (Moore-IVI)
W85-05724

STEADY WINTER CIRCULATIONS IN LAKES CONSTANCE AND KINNERET DRIVEN BY WIND AND MAIN TRIBUTARIES,
Israel Oceanographic and Limnological Research Ltd., Haifa.
S. Serruya, E. Hollan, and B. Bitsch.
Archiv fur Hydrobiologie, Supplement 70, No. 1, p 33-110, December, 1984. 40 Fig, 3 Tab, 44 Ref.

Descriptors: *Wind, *Tributaries, *Water circulation, *Lake Constance, *Lake Kinneret, Mathematical studies, Water currents, Stratification, Advection, Forcing.

The steady state circulation in Lakes Constance and Kinneret was studied mathematically to predict the large-scale advection of water masses, which is caused by wind forcing and the discharges of the main tributaries. Since the homogeneous distribution of mass involves a relatively simple mathematical formulation, the investigations concentrates on the conditions during the winter season when both lakes are not stratified. The modifications caused by a weak density stratification in the interim season of warming in spring and of strong cooling in autumn are also considered. A mathematical approach is used to describe the features of the two-dimensional, vertically integrated flow in the homogeneous lakes, a condition which is typical of a winter situation. Subsequently, the horizontal circulation is resolved locally for the vertical dependency of the current according to the system of drift and gradient currents. The additional calculation of the vertical component of motion provides complete information for the Lagrangian description of the field of motion, which is computed in several examples to illustrate the forecast in terms of three-dimensional trajectories. The considerations are supplemented by calculations of the equilibrium elevation of the surface and by a discussion on the limitations of the theoretical approach as well as on the modification due to the density stratification during the warm season. In the presence of a weak stratification, the steady current field does not undergo radical changes. (Moore-IVI)
W85-05727

FRACTIONATION OF ORGANIC AND INORGANIC PHOSPHORUS COMPOUNDS IN LAKE SEDIMENTS, AN ATTEMPT TO CHARACTERIZE ECOLOGICALLY IMPORTANT FRACTIONS (DIE FRAKTIONIERUNG ORGANISCHER UND ANORGANISCHER PHOSPHORVERBINDUNGEN VON SEDIMENTEN, VERSUCH EINER DEFINITION OKOLOGISCH WICHTIGER FRAKTIONEN),
Innsbruck Univ. (Austria).
R. Psenner, R. Pucsko, and M. Sage.
Archiv fur Hydrobiologie, Vol. 1, No. 1, p 111-155, December, 1984. 6 Fig, 10 Tab, 71 Ref.

Descriptors: *Phosphorus, *Lake sediments, *Organic compounds, Sediments, Phosphates, Sediment analysis, Iron oxides, Aluminum, Manganese oxides, Hydrogen ion concentration, Apatite, Redox potential.

An attempt was made to develop a procedure for fractionating sedimentary phosphorus compounds, to obtain a better chemical definition of several organic and inorganic phosphorus fractions. This aim was partially achieved by: testing the effect of single reagents upon the solubilization of pure substances and P fractions; avoiding the combination of extractants which act in different ways (reduction-chelation-complexation); excluding digestion steps for the determination of inorganic phosphorus; correlating phosphorus fractions with other sediment characteristics such as dissolved pore water phosphate, release rates, uptake capacity, redox potential and depth. This method is able to distinguish between phosphorus fractions which normally are treated together: Fe-P and Al-P = non apatite inorganic phosphorus. Iron and aluminum bound phosphates, having similar properties at very high pH values, react in a completely different way to changing environmental conditions such as temperature, pH and redox potential. By distinguishing between these two important inorganic compounds, other sediment qualities (such as release and uptake mechanisms) can be understood. The difference between total and inorganic phosphorus bound to iron and manganese oxides can amount to more than 100%. The fractionation procedure is useful for distinguishing between dissolved or water soluble phosphorus, reductant soluble phosphorus (bound to Fe and Mn oxides), NaOH-extractable P (Al-P and ligand exchangeable phosphate, mineral $FePO_4$ humic acid bound phosphorus), apatite phosphorus and refractory phosphorus. In each fraction, total and inorganic phosphorus was determined. The sum of all fractions correspond well with the total phosphorus content of the sediment, measured by different digestion methods. (Moore-IVI)
W85-05728

LONG-TERM WETLAND-WATERFOWL TRENDS IN SASKATCHEWAN GRASSLAND,
Ducks Unlimited Canada, Winnipeg (Manitoba).
W. G. Leitch, and R. M. Kaminski.
Journal of Wildlife Management, Vol. 49, No. 1, p 212-222, January, 1985. 2 Fig, 9 Tab, 32 Ref.

Descriptors: *Wetlands, *Waterfowl, *Grasslands, *Saskatchewan, Ducks, Reproduction, Prairies, Drought, Wildlife habitats, Wildlife conservation.

Wetland numbers, breeding duck populations, and brood production were monitored on a relatively pristine tract of grassland in south-central Saskatchewan from 1950 to 1975. Yearly number of wetlands (an index of wetland conditions) decreased an average of 55% between May and August 1950-75, but yearly numbers of May and August wetlands were positively correlated. Correlations among yearly numbers of adult ducks, their production, and yearly wetland numbers suggested that waterfowl recruitment from prairie environments with dynamic wetland regimes is a consequence of breeding population size, individual reproductive performance, and the persistence of suitable wetland conditions between spring and late summer. Duck populations that exploit variable prairie environments may exemplify temporally dynamic reproductive strategists and perhaps should not be labeled as either r- or K-strategies. Long-term duck population trends for the grassland site were compared with those from parkland areas in Alberta, Saskatchewan, and Manitoba. Both grassland and parkland populations increased with favorable wetland conditions during the 1950's but decreased during the drought of the early 1960's. Wetland conditions improved markedly during the late 1960's and early 1970's at the grassland site, and pair densities of most duck species were higher in the early 1970's than in the 1950's. In contrast, parkland populations generally decreased between the 1950's and 1970's. Relative abundances of mallard (Anas platyrhynchos) and blue-winged teal (A. discors) were similar during the 1950's and 1970's at the grassland site, whereas blue-winged teal outnumbered mallard at the parkland sites. The relatively pristine upland and wet-

land habitat of the grassland site, unlike the agriculturally impacted parkland sites, may have positively influenced duck populations in the grassland site, implicating increased need for complexes of quality wetland and upland habitat for enhancement of duck production. (Author's abstract)
W85-05734

NITROGEN FIXATION IN SUBARCTIC STREAMS INFLUENCED BY BEAVER (CASTOR CANADENSIS),
Woods Hole Oceanographic Institution, MA.
M. M. Francis, R. J. Naiman, and J. M. Melillo.
Hydrobiologia, Vol. 121, No. 3, p 193-202, February, 1985. 2 Fig, 4 Tab, 34 Ref.

Descriptors: *Nitrogen fixation, *Beavers, *Streams, Subarctic region, Wood, Sediments, Microorganisms, Beaver ponds, Riffles.

Nitrogen fixation was measured in four subarctic streams substantially modified by beaver (Castor canadensis) in Quebec. Acetylene-ethylene (C2H2 to C2H4) reduction techniques were used during the 1982 ice-free period (May-October) to estimate nitrogen fixation by microorganisms colonizing wood and sediment. Mean seasonal fixation rates were low and patchy, ranging from zero to 0.0023 micro-mol C2H4/sq cm/h for wood, and from zero to 0.0070 micro-mol C2H4/gAFDM/h for sediment; 77% of all wood and 63% of all sediment measurements showed no C2H2 reduction. Nonparametric statistical tests were unable to show a significant difference ($p > 0.05$) in C2H2 reduction rates between or within sites for wood species or by sediment depth. Nitrogen contributed by microorganisms colonizing wood in riffles of beaver influenced watersheds was small (e.g., 0.207 g N/sq m/y) but greater than that for wood in beaver ponds (e.g., 0.008 g n/sq m/y) or for streams without beaver (e.g., 0.003 g N/sq m/y). Although mass specific nitrogen fixation rates did not change significantly as beaver transform riffles into ponds, the nitrogen fixed by organisms colonizing sediment in pond areas (e.g., 5.1 g N/sq m/y) was greater than that in riffles (e.g., 0.42 g N/sq m/y). The annual nitrogen contribution is proportional to the amount of sediment available for microbial colonization. It is estimated that total nitrogen accumulation in sediment, per unit area, is enhanced 9 to 44 fold by beaver damming a section of stream. (Author's abstract)
W85-05737

INFLUENCE OF THE SURFACE MICROLAYER ON NUTRIENTS, CHLOROPHYLL AND ALGAL DIVERSITY OF A SMALL EUTROPHIC BOG POND,
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
K. W. Estep, and C. C. Remsen.
Hydrobiologia Vol. 121, No. 3, p 203-213, February, 1985. 4 Fig, 3 Tab, 46 Ref.

Descriptors: *Surface microlayers, *Nutrients, *Chlorophyll, *Algae, *Ponds, Bogs, Diatoms, Species diversity, Solar radiation, Eutrophication.

Samples were collected on 14 dates between May and October 1981 from a small, experimental pond near the edge of a bog in Wisconsin. A total of 71 species of algae in 45 genera were identified. Flagellates comprised the majority of cells on all dates and diatoms were often second in abundance. The nutrient chemistry analyses indicate that the surface microlayer of the experimental pond provided algae with conditions different from those at subsurface depths. Nutrient levels were consistently higher in a microlayer while algal abundance was sometimes higher but sometimes lower in the microlayer than at near subsurface depths. Algal diversity values were strongly influenced by the depth of flagellate blooms, and diversity in the microlayer was higher than at near subsurface depths. No correlation was found between algal enrichment and wind speed, sky cover or minutes of daylight for the time periods 6, 12 and 24 h before each sample collection. The microlayer community as a whole was dominated by healthy cells, although there was evidence of some damage due to solar radiation. The precipitous blooms which occurred at the surface indicate that the neuston can, under certain conditions, represent the site of maximum abundance for the entire water column. (Moore-IVI)
W85-05738

PLANKTON AND MATERIALS BUDGET OF THE MOSEL AT THE ENKIRCH STORAGE BASIN 1981 (PLANKTON UND STOFFHAUSHALT DER MOSEL BEI DER STAUHALTUNG ENKIRCH 1981),
Technische Hochschule Darmstadt (Germany, F.R.).
W. Rech, and R. Kinzelbach.
Hydrobiologia, Vol. 21, No. 3, p 215-235, February, 1985. 22 Fig, 17 Ref.

Descriptors: *Plankton, *Mosel River, *Nutrients, Nitrogen, Phosphorus, Oxygen depletion, Velocity, Water temperature, Solar radiation.

River plankton becomes an important factor in rivers affected by man, as a result of a permanent abundance of P and N, and of a lowering of current velocity transforming a river into a chain of storage basins. This process is demonstrated by means of data from the storage basin of Enkirch on the river Mosel, where in summer the growth of plankton leads to an oxygen deficiency. The mechanisms involved are shown. They are controlled by flow, global radiation, and temperature. (Author's abstract)
W85-05739

CARBON FLOW IN A SMALL TURBID MAN-MADE IMPOUNDMENT,
Orange Free State Univ., Bloemfontein (South Africa). Inst. of Environmental Sciences.
J. U. Grobbelaar, and D. F. Toerien.
Hydrobiologia, Vol. 121, No. 3, p 237-247, February, 1985. 1 Fig, 7 Tab, 26 Ref.

Descriptors: *Carbon, *Reservoirs, *Nutrient budget, Turbidity, Model studies, Phytoplankton, Fish, Bacteria, Zooplankton, Benthos, Detritus, Particulate matter, Dissolved solids, Primary productivity, Organic matter, Cycling nutrients.

A shallow turbid man-made impoundment was studied intensively for five years. The carbon (C) budget indicated a well balanced system, where phytoplankton productivity and respiratory losses accounted for the major inputs and outputs. The carbon content was dominated by dissolved organic carbon, followed by detritus > fish > phytoplankton > bacteria > zooplankton > zoobenthos. From an analysis of a matrix flow model, three dominant components of C-flow in the system were identified, i.e. dissolved inorganic carbon (DIC), particulate organic carbon (POC) and fish. Phytoplankton and detritus were the important components of POC. The largest flow of C was through the largest pool, dissolved inorganic carbon (DIC), while the second largest flow through the fifth largest pool, the phytoplankton. Phytoplankton was very important in determining the structure of the system, and variations in phytoplankton primary productivity influenced the entire system. This also applied to the input of organic material from macrophytes, but not to variations in the inflow of water from the impoundment. The input of detrital material from a littoral macrophyte community also markedly influenced the system. DOC was identified as a carbon buffer in the system, and differential flow occurred through this component upon variations in phytoplankton productivity. (Author's abstract)
W85-05740

LIMNOLOGY OF THE LAGO GRANDE DE ESTANYA (HUESCA) (LIMNOLOGIA DEL LAGO GRANDE DE ESTANYA (HUESCA)),
Barcelona Univ. (Spain). Dept. de Ecologia.
A. Avila, J. L. Burrel, A. Domingo, E. Fernandez, and J. Godall.
Oecologia Aquatica, Vol. 7, p 3-24, July, 1984. 11 Fig, 6 Tab, 23 Ref.

Descriptors: *Limnology, *Phytoplankton, *Zooplankton, *Chemical properties, *Lago Grande de Estanya, *Spain, Monomictic lakes, Thermal stratification, Nutrients, Alkalinity, Chlorophyll, Algae, Principal component analysis.

Phytoplankton, zooplankton and chemistry of the Lago Grande de Estanya in northwest Spain were studied between February, 1979, and March 1980. The lake is almost certainly fed by groundwater. The lake is monomictic, with thermal stratification extending from March to September. Surface temperature ranged from 6 C in February to 26.5 C in August. Judging from Secchi disk readings, light penetration was at a maximum (6.8 m) between November and February, and at a minimum in August (2.7 m) during a period of maximum phytoplankton abundance. Anaerobic conditions prevailed below the thermocline from June to October. Alkalinity ranged from 2 to 3.5 meg/l, with maximum values near the bottom in late October due to redissolution of carbonate sediments under anaerobiosis. Phosphate was very low (0 to 1 micro-g-at/l) in all samples. Nitrate ranged from 0 to 8.5 micro-g-at/l, with low values in summer. Vertical profiles of chlorophyll-a were quite homogeneous, but chlorophyll concentration was higher in spring and autumn than in summer. Phytoplankton abundance reached a maximum in the epilimnion in summer, with dominance of Planctonema lauterbornii and other Chlorococcales. A total of 90 phytoplankton taxa were identified. An annual succession of the phytoplankton groups was observed: Chlorophyceae dominated in the epilimnion in summer followed by dominance by dinoflagellates at the end of the season. Diatoms appeared with the onset of vertical mixing and remained abundant all through the winter. Chrysophyceae showed sporadic blooms in spring and autumn. Cryptophyceae developed mainly in winter and spring. Zooplankton is relatively species-poor. Principal component analysis was performed with 27 phytoplankton species and 8 zooplankton species. (Moore-IVI)
W85-05746

LIGHT ATTENUATION IN SPANISH RESERVOIRS. RELATIONSHIP WITH CHLOROPHYLL AND SUSPENDED PARTICULATE MATERIAL (EXTINCION DE LA LUZ EN LOS EMBALSES ESPANOLES. RELACIONES CON LA CONCENTRACION DE CLOROFILA Y LAS PATICULAS EN SUSPENSION),
Barcelona Univ. (Spain). Dept. de Ecologia.
V. Rulli, T. Vegas, and J. Navarro.
Oecologia Aquatica, Vol. 7, p 25-36, July, 1984. 13 Fig, 4 Tab, 13 Ref.

Descriptors: *Light attenuation, *Chlorophyll, *Suspended solids, *Reservoirs, *Spain, Opacity, Prediction, Multiple regression analysis.

Secchi disc depths (Ds), and extinction coefficients of total visible light (Kt) and of light transmitted by three different kinds of filters Ka, Kv, Kr, were obtained in 63 Spanish reservoirs. The best estimate of the constant relating Ds and Kt is given by $Kt = 1.75/Ds$. Light attenuation of green light (Kv) is low and regular, as expected. A multiple regression has been computed to relate Secchi disc depth to the extinction coefficients for total light using the different filters (table I). Once again Kv has more weight and is the best predictor. A number of types of water are identified, according to the relative values of the different partial extinction coefficients. The relation between Secchi disc depth and chlorophyll concentration is, in general, $Ds \cdot Cl0.17 = 3.5$ and, in spring, $Ds \cdot Cl0.44 = 1.72$. The prediction of chlorophyll concentration from Secchi disc readings is reliable only for Ds > 4 m. (Author's abstract)
W85-05747

ANNUAL CYCLE AND SPATIAL HETEROGENEITY OF THE ZOOPLANKTON IN A SERIES OF RESERVOIRS ON THE GUADIANA RIVER (CICLO ANUAL Y HETEROGENEIDAD ESPACIAL EN EL ZOOPLANCTON DE UNA CADENA DE EMBALSES DEL RIO GUADIANA),
Barcelona Univ. (Spain). Dept. de Ecologia.
J. Armengol.

Oecologia Aquatica, Vol. 7, p 43-72, July, 1984. 30 Fig, 4 Tab, 23 Ref.

Descriptors: *Zooplankton, *Reservoir operation, *Guadiana River, *Spain, Spatial distribution, Temporal distribution, Protozoa, Rotifers, Cladocera, Copepods, Flow discharge.

From October, 1976, to December, 1977, a chain of three reservoirs on the Guadiana River (SE Spain) was studied. The spatial and temporal variations of the zooplankton communities have been determined through bimonthly sampling at 10 stations. A total of 21 species were recorded: 4 protozoa, 11 rotifers, 4 cladocerans and 2 copepods. The temporal and spatial distribution of these species shows a number of regularities that have been studied using principal component analysis, analysis of variance and diversity indices. The zooplankton communities of these reservoirs are similar, but each reservoir retains a certain measure of individuality. The annual changes in the community composition show synchronic maxima for groups of species. Their sequence can be related to the environmental changes that take place during the year. Spatial heterogeneity was studied at two levels: changes within and between the sampling stations of each reservoir, especially between those located near the dam and in the river. In general, the heterogeneity is higher near river stations. In periods of high water discharge, the species with a high rate of reproduction (rotifers, protozoans) are dominant at these stations. On the contrary, when flow rate drops, cladocerans show characteristic pattern in relation to particular environmental conditions. The differences in the community composition between reservoir increase when discharge is at a minimum. (Author's abstract)
W85-05748

AQUATIC MACROPHYTE FLORA OF SALINE WETLANDS IN WESTERN AUSTRALIA IN RELATION TO SALINITY AND PERMANENCE,
Murdoch Univ. (Western Australia). School of Environmental and Life Science.
For primary bibliographic entry see Field 2L.
W85-05752

EPHEMERAL SALINE LAKES ON THE CANADIAN PRAIRIES: THEIR CLASSIFICATION AND MANAGEMENT FOR EMERGENT MACROPHYTE GROWTH,
Lethbridge Univ. (Alberta). Dept. of Biological Sciences.
V. J. Lieffers, and J. M. Shay.
Hydrobiologia, Vol. 105, p 85-94, November, 1983. 7 Fig, 2 Tab, 30 Ref.

Descriptors: *Saline lakes, *Lake management, *Macrophytes, *Saskatchewan, Ephemeral lakes, Emergent plants, Salinity, Lake sediments, Littoral zone, Water managment.

At two ephemeral saline lakes in Saskatchewan, changes in the physical and chemical features of water and sediments at various basin positions were monitored during a wet-dry cycle in 1978 and 1979. Water salinity fluctuated widely in response to changes in water volume and mass of solute in the water. When basins were dry, the soluble salt content of sediments 0-10 cm deep was higher then sediments 50-60 cm deep and sediments in the lake center were more saline than at the shoreline. Upon reflooding, there was a large immediate decrease in sediment salinity at the 0-10 cm depth, such that this layer was less saline than sediments 50-60 cm deep. Sediments in the lake center remained more saline than at the shoreline. Classification of lake salinity is necessary to assess the potential of a lake for emergent production. The large variances in ephemeral lake salinity due to water volume changes indicate that classification should be based upon the water volume-salinity cycle of these lakes rather than the salinity of any single water or sediment sample. Water management efforts to lower salinities, to improve these wetlands for emergent growth, should be aimed at reducing the salinity regime of the littoral zone. Flushing, dilution and drying and reflooding techniques are discussed as methods to decrease salinity. (Author's abstract)
W85-05753

PREDICTED EFFECTS OF INCREASING SALINITY ON THE CRUSTACEAN ZOOPLANKTON COMMUNITY OF PYRAMID LAKE, NEVADA,
Colorado Cooperative Fishery Research Unit, Fort Collins.
For primary bibliographic entry see Field 6G.
W85-05754

LIMNOLOGICAL CONTRASTS AND ANOMALIES IN TWO ADJACENT SALINE LAKES,
British Columbia Univ., Vancouver. Inst. of Animal Resource Ecology.
T. G. Northcote, and K. J. Hall.
Hydrobiologia, Vol. 105, p 179-194, November, 1983. 6 Fig, 5 Tab, 26 Ref. NSERC grants 67-3454 and 67-8935.

Descriptors: *Saline lakes, *Green Lake, *Limnology, *Mahoney Lake, *British Columbia, Stratification, Conductivity, Alkalinity, Calcite, Meromictic lakes, Dimictic lakes, Phytoplankton, Zooplankton, Bacteria, Geology, Topography.

Although closely situated saline lakes and ponds may show considerable variation in their physical-chemical and biological characteristics, few exhibit such striking differences as those found in two small permanent water bodies less than a kilometer apart in the southern Okanagan Valley of British Columbia. Mahoney Lake is strongly meromictic, while Green Lake is a more typical temperate dimictic lake. Surface waters of Mahoney Lake shortly after ice-out are over 4 times the conductivity of Green Lake and by mid-June, almost 6 times higher. The high alkalinity and a pH above 8.5 favor the formation of carbonate and precipitation of calcite in the water column of Green Lake and the surface waters of Mahoney. Although the lake basins are morphometrically similar, differences in their watershed geology and topography in large part may be responsible for the more saline lake showing severe and anomalous meromictic features while the less saline lake exhibits normal dimictic characteristics. Bacterial and phytoplankton biomass and productivity information suggest that Green Lake is dominated by phytoplankton carbon fixation while Mahoney is mainly dominated by a bacterial-detritus based system. In Mahoney Lake, zooplankton abundance was greatly reduced in the upper anoxic layer at 1.5 m, while there were two distinct concentration zones of phytoplankton, one in the uppermost meter and another between 2 and 7 m. (Moore-IVI)
W85-05755

SEASONAL CHANGES IN THE CHEMISTRY AND BIOLOGY OF A MEROMICTIC LAKE (BIG SODA LAKE, NEVADA, U.S.A.),
Geological Survey, Menlo Park, CA.
J. E. Cloern, B. E. Cole, and R. S. Oremland.
Hydrobiologia, Vol. 105, p 195-206, November, 1983. 5 Fig, 2 Tab, 32 Ref.

Descriptors: *Seasonal variation, *Chemical properties, *Big Soda Lake, *Nevada, Meromictic lakes, Alkaline lakes, Saline lakes, Phytoplankton, Chlorophyll, Nutrients, Dissolved oxygen, Water temperature, Bacteria, Photosynthesis.

Big Soda Lake is an alkaline, saline lake with a permanent chemocline at 34.5 m and a mixolimnion that undergoes seasonal changes in temperature structure. During the period of thermal stratification, from summer through fall, the epilimnion has low concentrations of dissolved inorganic nutrients (N, Si) and CH4, and low biomass of phytoplankton (chlorophyll a approximately 1 mg/cu m). Dissolved oxygen disappears near the compensation depth for algal photosynthesis (about 20 m). Surface water is transparent so that light is present in the anoxic hypolimnion, and a dense plate of purple sulfur photosynthetic bacteria (Ectothiorhodospira vacuolata) is present just below 20 m (Bchl a approximately 200 mg/cu m). Concentrations of NH4(+), Si, and CH4 are higher in the hypolimnion than in the epilimnion. As the mixolimnion becomes isothermal in winter, oxygen is mixed down to 28 m. Nutrients (NH4(+), Si) and CH4 are released from the hypolimnion and mix to the surface, and a diatom bloom develops in the upper 20 m (chlorophyll a > 40 mg/cu m). The deeper mixing of oxygen and enhanced light attenuation by phytoplankton uncouple the anoxic zone and photic zone, and the plate of photosynthetic bacteria disappears (Bchl a approximately 10 mg/cu m). Hence, seasonal changes in temperature distribution and mixing create conditions such that the primary producer community is alternately dominated by phytoplankton and photosynthetic bacteria: the phytoplankton may be nutrient-limited during periods of stratification and the photosynthetic bacteria are light-limited during periods of mixing. (Author's abstract)
W85-05756

LIMNOLOGY OF GALLOCANTA LAKE, ARAGON, NORTHEASTERN SPAIN,
Barcelona Univ. (Spain). Dept. de Ecologia.
F. A. Comin, M. Alonso, P. Lopez, and M. Comelles.
Hydrobiologia, Vol. 105, p 207-221, November 1, 1983. 12 Fig, 1 Tab, 57 Ref.

Descriptors: *Limnology, *Saline lakes, *Gallocanta Lake, *Spain, Salinity, Phosphorus, Nitrogen, Zooplankton, Phytoplankton, Macrophytes, Drought.

A limnological study was conducted from September 1980 to October 1981 to show the evolution of Gallocanta Lake (N.E. Spain) under very dry climatic conditions. It is the physical terminus within an endorheic basin of 500 sq km situated 1,000 m above sea level. In 1977 its maximum depth was 2.5 m but it decreased to 60 cm in 1981 as a consequence of several very dry years. It is 6 km long and 2.5 km wide, and its area is approximately 12 sq km. Salt concentration was quite constant (32-43 g/l) from September 1980 until June 1981. The equivalent ratio Cl(-):SO4(2-) varied between 2.2 and 2.8. From June through October 1981 salinity increased up to 105 g/l and Cl(-):SO4(2-) equivalent ratio varied between 2.5 and 3.4. The relative concentrations of ions were retained all year ordinated as follows: Cl(-) > SO4(2-) > HCO3(-) >. CO3(2-); Na(+) > Mg(2+) >> Ca(2+) > K(+). Total reactive phosphorus was less than 1.5 micro-g-at/l from September 1980 to January 1981. During the rest of the studied period it varied between 2 and 8 micro-g-at/l (the maximum, in February 1981). Nitrogen oxidized forms were relatively high in winter (4-8 micro-g-at N-NO-3/l; 0.5-2.5 micro-g-at N-NO-2/l), and early May 1981 (25 micro-g-at N-NO-3/l; 1 micro-g-at N-NO-2/l). Neither reached 1 micro-g-at/l from September through December 1980, or from June through October 1981. Planktonic algae increased in density during the period of the study from 1000 to 500,000 cells/ml. Chromulina sp. was the main species during autumn and winter (> 50% in number of cells/ml) while the copepod Arctodiaptomus salinus decreased its population. Lobocystis dichotoma increased its density from December 1980 to May 1981 and was dominant in spring (> 90%), when a typical reproductive activity was observed in the Arctodiaptomus population. This species disappeared in late spring. In June 1981 Brachionus plicatilis reached up to nearly 2,000 individuals/ml. This species was not observed after August 1981. Then the ciliate Fabrea salina was the only zooplankter staying in the free waters of the lake and Nannochloris sp. the dominant alga (> 90%). Dense macrophytic beds constituted of Lamprothamnium papulosum and Chara galioides covered the bottom of the lake in September 1980 and before that date since the observations began in 1977. The decreased in covered area since October 1980 and disappeared during summer 1981. Gallocanta Lake is in a very stressed situation produced by prolonged drought. The increased salt concentration together with the extremely cold and hot temperatures, and the lack of nitrogen relative to phosphorus are the main environmental factors that controlled the biological populations

during the period of the present study. (Author's abstract)
W85-05757

LARGE, DEEP SALT LAKES: A COMPARATIVE LIMNOLOGICAL ANALYSIS,
California Univ., Santa Barbara. Dept. of Biological Sciences.
J. M. Melack.
Hydrobiologia, Vol. 105, p 223-230, November, 1983. 1 Fig, 1 Tab, 58 Ref.

Descriptors: *Saline lakes, *Limnology, *Mono Lake, *California, *Qinghai Hu, *China, Altitude, Stratification, Dissolved oxygen, Supersaturation, Alkalinity, Phosphates, Nitrogen, Transparency, Algae, Aquatic animals.

Among athalassic salt lakes of the world large, deep lakes are rare. A comparative analysis of Mono (USA), Walker (USA), Qinghai Hu (China), Shala (Ethiopia), Van (Turkey), Panggong Tso (Indian Tibet) and Karakul (USSR) (with emphasis on Mono and Quighai Hu) reveals a number of ecological similarities. The criteria of selection were a mean depth greater than 15 m, an area greater than 100 sq km and a salinity greater than 10 g/l and less than 100 g/l. The Aral and Caspian Seas were excluded because of the relict marine affinities of their biota. Large, deep salt lakes are located at moderate to high altitude in mountainous terrain: they stratify and mix at least once per year, and dissolved oxygen is depleted in the hypolimnia of most. The lakes contain alkaline, sodium rich waters with considerable chloride, sulfate and carbonate plus bicarbonate. Phosphate concentrations are usually high while inorganic nitrogen varies widely. Secchi disk transparency ranged from < 1 m to ca. 20 m. Supersaturation of dissolved oxygen, abundant animals and seasonally high algal populations indicate that some of the lakes are productive. All except Mono contain fish. (Author's abstract)
W85-05758

AUSTRALIAN SALT LAKES: THEIR HISTORY, CHEMISTRY, AND BIOTA - A REVIEW,
Australian National Univ., Canberra. Dept. of Biogeography and Geomorphology.
P. De Deckker.
Hydrobiologia, Vol. 105, p 231-244, November 1, 1983. 3 Fig, 1 Tab, 107 Ref.

Descriptors: *Saline lakes, *History, *Chemical properties, *Aquatic life, *Australia, Crater lakes, Sodium, Chloride, Calcium sulfate, Sodium carbonate, Crustaceans, Distribution, Climate.

A vast number of large lakes (>> 100 sq km) are typically very old features of the Australian landscape; they occupy areas which have changed little tectonically (e.g., they occupy ancient drainage systems in Western Australia or lie in deep depressions such as the Great Artesian Basin: Lake Eyre) and have not been transgressed by the sea since at least the Paleogene. Other salt lakes, most of which are small (<< 50 sq km), have been affected morphologically during recurring glacial-interglacial cycles (e.g., lakes associated with gypsum or clay lunettes, sabkhas, pans, lakes near the coast behind barrier dunes as a result of sea-level changes) and their sedimentary records represent comparatively much shorter periods of time. Ther are also a number of unusually young (< 30,000 years) crater lakes, some of which are the best studied lakes in Australia. The major ions encountered today in Australian salt lakes consist of sodium and chloride although some lakes are also calcium sulfate rich. The origin of these ions is briefly discussed. Sodium carbonate lakes are rare in Australia today. Under past climatic/hydrological conditions the chemistry of a number of lakes was apparently different. The biota of Australian salt lakes is mostly endemic; it is highly diversified as witnessed by the crustacean fauna and is well adapted to the harsh conditions prevailing in saline water. This is the result of a long history of aridity in Australia. The characteristics of this biota are presented together with data on its distribution which is primarily related to climatic conditions. (Author's abstract)
W85-05759

SEDIMENTOLOGY AND GEOCHEMISTRY OF SALINE LAKES OF THE GREAT PLAINS,
Manitoba Univ., Winnipeg. Dept. of Earth Sciences.
W. M. Last, and T. H. Schweyen.
Hydrobiologia, Vol. 105, p 245-263, November, 1983. 15 Fig, 5 Tab, 54 Ref.

Descriptors: *Sedimentology, *Geochemistry, *Saline lakes, *Great Plains, Hypersaline lakes, Lake sediments, Playas, Chemical precipitation, Evaporation, Groundwater, Freeze-out, Detritus, Sedimentation.

Southern Saskatchewan and portions of adjacent Alberta, North Dakota and Montana are occupied by hundreds of saline and hypersaline lakes ranging from small prairie potholes (less than 1 sq km) to relatively large bodies of water (greater than 300 sq km). From a sedimentological perspective, distinction must be made between two basic types of saline lakes: playas and perennial lakes. Calcium, sodium and magnesium sulfates, carbonates and bicarbonates form as chemical precipitates in lakes with more concentrated brines. In addition, experimental data suggests mixed layer smectites may form authigenically in some lakes. Clastic sediments in the salt lakes consist mainly of silt and clay-sized quartz, feldspars, carbonates and clay minerals. The dominant physical and chemical processes which are responsible for and act upon the sediment vary widely, mainly in response to basin morphology and brine chemistry. Evaporative concentration and significant groundwater contributions affect all the saline lakes. However, other processes are different in the two basic types of basins. The playa lakes are influenced by: evaporitic pumping and the formation of efflorescent crusts and intrasedimentary crystals, cyclic wetting and drying, precipitation of highly soluble salt layers, and influx of clastic debris by sheetflood and wind. In contrast, in the permanent lakes, precipitation of sparingly soluble salts occurs due to the interaction of biological activity, seasonal temperature fluctuations and brine mixing. In addition, many of the permanent lakes undergo freeze-out precipitation of very soluble salts under a winter ice cover. Detrital sediments are distributed within the basins by normal lacustrine processes, including shoreline deposition and erosion, turbidity flow and pelagic fallout. (Author's abstract)
W85-05760

GEOCHEMISTRY OF GREAT SALT LAKE, UTAH I: HYDROCHEMISTRY SINCE 1850,
Calgary Univ. (Alberta). Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2K.
W85-05761

GROUND WATER AS A SILICA SOURCE FOR DIATOM PRODUCTION IN A PRECIPITATION-DOMINATED LAKE,
Wright State Univ., Dayton, OH. Dept. of Geology.
J. P. Hurley, D. E. Armstrong, G. J. Kenoyer, and C. J. Bowser.
Science, Vol. 227, No. 4694, March 29, 1985. 2 Fig, 1 Tab, 12 Ref. NSF contract DEB 8012313.

Descriptors: *Silica, *Groundwater, *Diatoms, *Crystal Lake, *Wisconsin, Seasonal variation, Oligotrophic lakes, Cycling nutrients.

To determine the importance of ground water as a silica source for diatom production, an investigation was made of the relation between changes in the biogenic silica content of the water column and the timing and magnitude of silica inputs and outputs at Crystal Lake, an oligotrophic lake in northern Wisconsin. Changes in the silica content of the lake were determined from measurements of the forms and concentrations of silica as a function of time and depth coupled with lake bathymetry. Silica originating in ground water is cycled in the lake approximately 2.5 times during the year, once through direct incorporation into diatom biomass and about 1.5 times through use of silica produced by regeneration. Analyses of bottom sediments indicate that the silica in the lake is approximately at steady state on an annual basis. The net accumulation of particualte biogenic silica in the deep hole sediments is about 4.6 g/sq m/yr and has not changed significantly over the last 175 years. The corresponding lakewide sediment accumulation rate (275 kg/year) is not significantly different from the ground water input (210 kg/year). Clearly, silica supplied from ground water is the ultimate control on silica cycling in Crystal Lake. (Baker-IVI)
W85-05775

COMPUTER ANIMATION OF STORM SURGE PREDICTIONS,
Ohio State Univ., Columbus. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W85-05784

CIRCULATION STRUCTURE IN A STRATIFIED CAVITY FLOW,
Stanford Univ., CA. Dept. of Civil Engineering.
J. R. Koseff, and R. L. Street.
Journal of Hydraulic Engineering, Vol. 111, No. 2, p 334-354, February, 1985. 18 Fig, 27 Ref, 1 Append. NSF grant CME-7921324 and Division of Engineering, Mathematical and Geosciences, Office of Basic Energy Sciences, DOE contract DOE-DE-AT03-81-ER-10867.

Descriptors: *Circulation, *Stratification, *Cavity flow, *Mixing, *Lakes, Richardson numbers, Thermoclines, Water temperature.

Experiments were conducted to study the circulation patterns and mixing processes in a stratified, lid-driven cavity flow. The ratio of the cavity depth to width used was 1:1 and that of span to width was 3:1. The flow is different from those reported in the literature in up to four ways: Recirculation is a dominant feature; temperature control is used to obtain the stratification; the upper and lower boundaries are held at different constant temperatures; and the flows considered are, at most, only partially turbulent. For the geometric configuration used, the following may be concluded about the flow. The flow is strongly three-dimensional. The number of circulation cells expected in this stratified flow can be estimated form the value of the bulk Richardson number, Ri sub b. Given a local Richardson number, Ri, the entrainment rate, E, is found to be proportional to Ri to the -1.4 power, indicating a shear-induced mixing process related to the recirculation. Taylor-Gortler-like vortices above the thermocline are significant contributors to the mixing process. (Author's abstract)
W85-05787

PLANKTONIC AND BENTHIC BACTERIAL POPULATIONS OF LOUGH NEAGH,
New Univ. of Ulster, Coleraine (Northern Ireland). Limnology Lab.
J. P. Quinn, M. B. Gillan, and H. McGrogan.
Journal of Applied Bacteriology, Vol. 58, No. 1, p 87-93, January, 1985. 4 Fig, 32 Ref.

Descriptors: *Bacteria, *Benthos, *Plankton, *Lough Neagh, *Northern Ireland, *Population dynamics, Species composition, Lakes, Aeromonas, Eutrophic lakes.

The planktonic and benthic bacterial populations of Lough Neagh, Northern Ireland, were studied over a one-year period. Direct counts of bacteria in the water column averaged 60,000,000/ml with limited spatial or temporal variation; viable counts, however, showed a pronounced late spring maximum of 1.7 x 10 to the 7th power/ml and were consistently higher at a littoral sampling station. Direct counts of bacteria in the profundal sediments averaged 8 x 10 to the 9th power/ml while viable benthic counts rose steeply during spring to reach a June maximum of 1 x 10 to the 8th power/ml. Direct:viable count ratios were much greater in the more sandy littoral zone. The predominant benthic isolate was an Aeromonas sp. which was also common in samples from the water column. These results confirm the eutrophic status of

Lough Neagh indicated by other biological and chemical surveys. (Author's abstract)
W85-05807

2I. Water In Plants

AGRICULTURAL DROUGHTS AND CROP PLANNING - A CASE STUDY FOR WESTERN RAJASTHAN,
Central Arid Zone Research Inst., Jodhpur (India).
For primary bibliographic entry see Field 2B.
W85-05076

RESPONSE OF COTTON WATER STRESS INDICATORS TO SOIL SALINITY,
Agricultural Research Service, Fresno, CA.
T. A. howell, J. L. Hatfield, J. D. Rhoades, and M. Meron.
Irrigation Science, Vol. 5, No. 1, p 25-36, April, 1984. 7 Fig, 2 Tab, 22 Ref.

Descriptors: *Water stress, *Cotton, *Saline soils, Water deficit, Salinity, Soil properties, Canopy, Temperature effects, Leaves, Water potentials, Irrigation effects, Crop yield.

Crop water stress results from water deficiencies in plant tissues that impair the plant's growth processes. A field study was conducted on cotton to investigate the effects of soil salinity on the response of stress indices derived from canopy temperature, leaf diffusion resistance and leaf water potential. The four salinity treatments used in this study were obtained by mixtures of aqueduct and well water to provide mean soil water electrical conductivities of 17, 27, 32, and 38 dS/m in the upper 0.6 m of soil profile. The study was conducted on a sandy loam saline alkali soil in the lower San Joaquin Valey of California on 30 July 1981. The soil profile was adequately irrigated to remove any interference of soil matric potential on the stress measurements. The crop water stress index, which requires measurements of canopy temperature, ambient vapor pressure deficit and ambient air temperature, does indicate the water stress in cotton which develops when the soil salinity increases in the absence of soil water matric stress. Previous research has indicated the performance of the crop water stress index to measure cotton performance under soil water matric stresses in absence of soil osmotic stress. The infrared thermometer offers a handy instrument for field use to integrate the crop stress over a larger area than can be accomplished by measurements of individual leaves. Although the results reported indicate a good correlation between final lint yield of cotton and the crop water stress index, additional research should be conducted to determine if such relationships are similar if the stress vectors are different and to identify the effects of crop osmotic adjustment on the relationship. (Baker-IVI)
W85-05164

STUDIES ON THE NITROGEN AND WATER RELATIONS OF WHEAT, II. EFFECTS OF VARYING NITROGEN AND WATER SUPPLY ON GROWTH AND GRAIN YIELD,
Waite Agricultural Research Inst., Glen Osmond (Australia).
K. V. M. Parameswaran, R. D. Graham, and D. Aspinall.
Irrigation Science, Vol. 5, No. 2, p 105-121, April, 1984. 5 Fig, 9 Tab, 26 Ref.

Descriptors: *Nitrogen, *Wheat, *Plant growth, *Water demand, Irrigation, Fertilizers, Crop yield, Water stress, Water potential, Leaves, Tillering.

Wheat was grown in field and glasshouse experiments to assess the effect of nitrogen fertilizer on yield when water stress occurred in the latter half of the growth. The studies of nitrogen x water interactions on grain yield of wheat were unable to associate variations in grain yield due to nitrogen causally to tillering per se, differential root development, post-anthesis plant water potential, leaf diffusive resistance or post-anthesis leaf area duration. Undoubtedly, grain yield is related to tiller survival but the mechanism may be linked to effects of nitrogen on the efficiency of retranslocation of substrates from senescing plant parts, a process which in itself is relatively insensitive to water stress. The thought that plants should be bred with a high post-anthesis leaf area duration in order to improve grain yield may be risky in an environment where water is a dominant factor late in the season. (Baker-IVI)
W85-05167

SIMULATION OF POSSIBLE ADAPTIVE MECHANISMS IN CROPS SUBJECTED TO WATER STRESS,
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
J. W. Jones, and B. Zur.
Irrigation Science, Vol. 5, No. 4, p 251-264, December, 1984. 6 Fig, 1 Tab, 26 Ref.

Descriptors: *Water stress, *Transpiration, *Soil-water-plant relationships, Drought resistance, Roots, Leaves, Water potentials, Photosynthesis, Crop yield, Diurnal variations, Stomatal resistance, Osmotic adjustment.

Water deficits develop in plants as a result of an imbalance between water loss from the leaves and water uptake by roots. Possible adaptive mechanisms in water spender and water saver crops subjected to drought have been simulated. These mechanisms (root extension, increased initial stomatal resistance, and osmotic adjustment) are examined for a range of soil, plant and atmospheric conditions using a dynamic soil-plant water model. Results suggest that for increased agricultural production in environments conducive to the development of severe water stresses, adaptive mechanisms associated with water spenders would be most effective. In particular, an effective mechanism would be root extension into deeper soil layers wetted by rain or irrigation but normally not penetrated by roots because of genetic, mechanical or chemical reasons. The additional soil volume penetrated by the roots would insure maintenance of a favorable crop water balance for longer times, which in turn would allow for longer periods of expansive growth and uninhibited photosynthesis. The price to be paid would be an increased water use of the crop. The additional water would be extracted from soil layers normally not effectively utilized by the crop. Increased root proliferation of agricultural crops could be achieved by proper breeding and by agro-technical practices which would enhance root penetration and proliferation into deeper soil layers. (Baker-IVI)
W85-05170

EFFECT OF SOIL MOISTURE REGIMES ON THE YIELD AND WATER USE OF LENTIL (LENS CULINARIS MEDIC),
Indian Agricultural Research Inst., New Delhi. Water Technology Center.
S. N. Sharma, and R. Prasad.
Irrigation Science, Vol. 5, No. 4, p 285-293, December, 1984. 4 Fig, 3 Tab, 11 Ref.

Descriptors: *Soil water, *Irrigation, *Crop yield, *Lentils, Evaporation, Crop yields, Seasonal variations, Consumptive use.

Grain and straw yield, consumptive water use (Cu) and its relation with evaporation from free water surface (Eo), water use efficiency and soil moisture extraction pattern of lentil were studied under different soil moisture regimes. With an increase in irrigation frequency, the grain and straw yield, consumptive water use rate, Cu/Eo ratio and water use efficiency increased as well. As the crop season advanced and reached its peak value during flowering and grainfilling stages the consumptive water use rate increased. At 35 and 105 days after sowing, branching and grain filling stages, the Cu/Eo ratio attained its minimum values. The top soil layer, 0-30 cm, experienced the most severe depletion of soil moisture, followed by the 30-60 cm layer and moisture loss was least from the 90-120 cm layer. The pattern of soil moisture depletion was also influenced by soil moisture regime. The percent contribution from the top soil layer decreased and that from the lower soil layers increased during the vegetative and flowering stages with an increase in the soil moisture tension. The actual amount of moisture depleted from all the soil layers was always higher under low soil moisture tension regime than under high soil moisture tension regime. The soil moisture treatment had no significant effect on the relative contribution from different soil layers under low and high soil moisture tension during the grain development stages as the crop was irrigated at the same time under both these treatments. With no irrigation, the percent contribution from top soil layer continued to decrease, and to increase from lower soil layers, as the crop advanced from flowering stage to grain development stage. On coarse textured soils lentil crop irrigation at a soil moisture tension of 0.05MPa gave high grain yields. Reasonably good yields were obtained with irrigations at 0.25 MPa matrix potential. The branching and grain development stages of lentil were found to be most critical for water requirement. (Baker-IVI)
W85-05171

EFFECT OF DISTURBED SOIL THICKNESS ON SOIL WATER USE AND MOVEMENT UNDER PERENNIAL GRASS,
Science and Education Administration, Mandan, ND. Northern Great Plains Research Center.
S. D. Merrill, S. J. Smith, and J. F. Power.
Soil Science Society of America Journal, Vol. 49, No. 1, p 186-202, January-February, 1985. 6 Fig, 2 Tab, 23 Ref.

Descriptors: *Plant growth, *Soil thickness, *Grasses, *Water use, Permeability coefficient, Mine wastes, Soil properties, Soil water, Roots, Land reclamation, Water potentials, Evapotranspiration.

An understanding of plant growth response to soil thickness over sodic minespoils was sought by measurement of water movement, water use, and root growth. Soil water storage and use were measured in each of three growing seasons under crested wheatgrass grown on 0.25-, 0.5-, 0.75-, and 1.0-m thicknesses of disturbed soil. Forage yield was 2- to 3.5-fold greater on 1.0 m soil thickness than on 0.25 m. Both total soil water potentials and root weight densities were similar in minespoil and in subsoil at the same profile depths. Root water uptake was much less from the minespoil than from subsoil. Low hydraulic conductivity (HC) per se appeared to be the dominant factor limiting sodic minespoil as a plant growth medium. Low HC resulted in less use of stored soil water from minespoil compared to subsoil. Relative differences in evapotranspiration between the 0.25 m and 1.0 m soil thickness treatments were much less than yield differences, reflecting progressively reduced water use efficiency with less soil thickness. (Baker-IVI)
W85-05190

AGRICULTURAL DROUGHT ASSESSMENTS USING A CROP MODEL.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
For primary bibliographic entry see Field 2A.
W85-05332

CONSUMPTIVE USE OF WATER BY MAJOR CROPS IN THE SOUTHWESTERN UNITED STATES,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
L. J. Erie, O. F. French, D. A. Bucks, and K. Harris.
Conservation Research Report No. 29, Agricultural Research Service. 40 p, 11 Ref, 3 Append.

Descriptors: *Consumptive use, *Soil water, *Soil-water-plant relationships, Soil moisture retention, Vegetable crops, Fruit crops, *Irrigation requirements, Forages, Grain crops, Soil moisture meters, Grasses, Crop production, *Arizona.

Consumptive use of water by plants is defined as the unit amount of water used on a given area in transpiration, building of plant tissues, and evaporation from adjacent soil. Knowledge of consump-

tive use is necessary in planning farm irrigation and drainage systems, for improving irrigation practices, conserving energy, and assisting in irrigation scheduling. Consumptive use is affected by many management factors and such natural factors as climate, soils, and topography. Management factor may include water supply, quality, and crop variety, fertility, planting date, spacing, irrigation scheduling, cultivation and chemical spraying. The most common methods of measuring the amount of water consumed by crops have been lysimeters, water balance, and soil moisture depletion. A study of consumptive use of water by various cash, oil, hay, bermuda lawn, small grain, forage, fruit, vegetable, and green manure crops as grown in central Arizona was made by gravimetric soil water content measurements on soil samples taken at various depths and locations. Consumptive use curves were developed from the averages for several years. Tentative irrigation schedules can be calculated directly from the consumptive use curves for areas having growing seasons comparable to those in the Salt River Valley of Arizona. Direct transfer of the measured consumptive-use data in this report to an area of similar latitude, temperature, humidity, cloud cover, and wind as Phoenix is also possible.
W85-05346

EFFECT OF GIBBERELLIC ACID ON THE BUOYANCY OF SPIRODELA INTERMEDIA W. KOCH,
Universidad Nacional del Sur, Bahia Blanca (Argentina). Dept. de Agronomia.
For primary bibliographic entry see Field 5G.
W85-05610

SUBMERGED MACROPHYTES AND THE HYDRAULIC ROUGHNESS OF A LOWLAND CHALKSTREAM,
Freshwater Biological Association, Wareham (England). River Lab.
F. H. Dawon, and W. H. Robinson.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1944-1948, December, 1984. 5 Fig, 10 Ref.

Descriptors: *Chalkstreams, *Macrophytes, *Hydraulic roughness, Submerged plants, Seasonal variation, Water levels, Aquatic plants, Roughness coefficient, Population dynamics, Species diversity, Velocity.

Information was sought on the seasonal variation of water velocity and hydraulic roughness of a large managed chalkstream as it relates to submerged macrophyte population. A preliminary study was made of the nature of the hydraulic roughness of plant stands both directly and through the development of models in preparation for further work on metabolic changes with velocity. These data are combined to show the role of plants in river energy changes. Water depth and velocity varied in response to discharge in winter, but additionally and more significantly to the plant growth in the spring and summer. Hydraulic roughness increased (as Manning's n) from a winter level of 0.03-0.04 to either about 0.06 in early spring, or about 0.11 in late spring. The relationship of hydraulic roughness with discharge was constant within a small range, for periods between major discharge changes after each of which a new relationship was established. The latter resulted from the removal of excess or moribund plant material particularly in the autumn, the redistribution of unstable sediments and the compaction of the stems within stands. The population density of plants was 1 per 6.6 sq m for sections of depth range 0.85-1.53 m to 1 per 3.1 sq m for the shallower section of 0.52-1.31 m in depth. (Baker-IVI)
W85-05675

CANOPY CONDUCTANCE OF CONIFEROUS FORESTS RELATED TO CLIMATE,
Sveriges Lantbruksuniversitet, Uppsala. Inst. foer Ekologi och Miljoevaard.
A. Lindroth.
Water Resources Research, Vol. 21, No. 3, p 297-304, March, 1985. 6 Fig, 1 Tab, 34 Ref.

Descriptors: *Canopy conductance, *Conductance, *Climate, *Solar radiation, Evapotranspiration, Seasonal variation, Stomatal efficiency, Leaves.

Canopy conductance, G, and specific canopy conductance, g, were estimated from Bowen ratio measurements above a sparse Scots pine forest. Both conductances increased with increasing solar radiation, R sub g, with the highest sensitivity in the low R sub g range. Above 400-500 W/sq m they were practically constant with respect to Rg. During typical daytime situations the conductances depended primarily on vapor pressure deficit, VPD. For R sub g above 500 W/sq m, g decreased from 11 mm/s at a VPD of 300 Pa down to 5.5 mm/s at 800 Pa, then more slowly down to 3 mm/s at 2000 Pa. The diurnal variation of g was characterized by a rapid increase in the morning up to about 6 mm/s, then g slowly decreased until noon and recovered somewhat in the afternoon to decrease again down to about 2.5 mm/s in the evening. From May to August the projected needle area index varied from 2.0 to 2.6, whereas total canopy conductance increased by 100% due to variations in climate (50%), needle area (30%), and stomatal efficiency (20%). Comparison between three forests indicated that it was more important to understand the mechanisms behind the seasonal variation of G than to assess differences in G between forests, these latter differences being remarkably small. (Author's abstract)
W85-05792

2J. Erosion and Sedimentation

QUANTITATIVE EVALUATION OF SEDIMENT DELIVERY RATIOS,
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
R. M. Khanbilvardi, and A. S. Rogowski.
Water Resources Bulletin, Vol. 20, No. 6, p 865-874, December, 1984. 4 Fig, 4 Tab, 24 Ref.

Descriptors: *Sedimentation, *Sediment yield, *Model studies, *Hastings, *Nebraska, Erosion, Deposition.

Ability to adequately estimate sediment yield under current or alternative land use conditions is an important step in identifying and dealing effectively with soil erosion problems. Sediment yield was computed for two watersheds in Hastings, Nebraska, and compared with ten years of measured sediment yield data. The Universal Soil Loss Equation (USLE) with different forms of sediment delivery ratio (SDR) were compared with those made by Modified USLE (MUSLE) and a fundamentally derived Erosion-Deposition Model (EDM). The USLE and USLE with SDR are poor predictors of sediment yield for individual storms compared to the MUSLE and EDM. Although MUSLE gave better results than USLE it showed somewhat more scatter of data points, but less bias in predictions, than the recently developed EDM. Both MUSLE and EDM approximated quite closely the variance observed on the measured field data. (Collier-IVI)
W85-04993

IDENTIFICATION OF CRITICAL AREAS ON FOREST LANDS FOR CONTROL OF NONPOINT SOURCES OF POLLUTION,
East-West Environment and Policy Inst., Honolulu, HI.
W. F. Megahan, and P. N. King.
Environmental Management, Vol. 9, No. 1, p 7-17, January, 1985. 70 Ref.

Descriptors: *Forest management, *Erosion, *Nonpoint pollution, Sediments, Water pollution sources, Runoff, Soil conservation, Water pollution control.

Pollution resulting from the management of forest lands is of a nonpoint character and is of two general types. One type involves changes in naturally occuring water constituents caused by the disruption of the natural ecosystem by various practices. This includes changes in sediment, dissolved chemical transport, and water temperature. A second type of pollutant consists of exotic substances introduced by management practices and includes bacteriological pollutants and chemicals such as pesticides, fertilizers, and fire retardants. Most nonpoint source pollution problems on forest lands can be controlled by careful planning and management of specific critical areas. Critical areas include sites with high mass and surface erosion hazards, overland flow areas, and the riparian zone. Improving land-use practices to avoid exceeding the capability of the land to sustain permitted activities is a necessary long-term task requiring education, extension, and incentives to institute soil conservation practices. (Collier-IVI)
W85-05068

CHANNEL CHANGE, SEDIMENT TRANSPORT, AND FISH HABITAT IN A COASTAL STREAM: EFFECTS OF AN EXTREME EVENT,
Center for Natural Resource Studies, Berkeley, CA.
For primary bibliographic entry see Field 2E.
W85-05069

ANGOSTURA RESERVOIR, 1979 SEDIMENTATION SURVEY,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
J. M. Lara.
Available from the National Technical Information Service, Springfield, VA 22161. August 1983. 105 pp, 82 Fig, 4 Tab, 4 Ref.

Descriptors: *Reservoir silting, *Sedimentation, *Reservoir capacity, *Sediment distribution, *Sedimentation survey, Silting, Sonar, Surveys, Angostura Reservoir, Wyoming, *South Dakota.

This report presents a study of sediment accumulations in the Angostura Reservoir over 29.6 years of the reservoir's operation. Data gathered was used to compute a revised reservoir capacity due to the volume of accumulated sediment since the dam was closed in 1949. Sixteen sediment samples were collected from reservoir deposits at various sediment ranges in the upstream portion of the reservoir. Sonic depth recording equipment was used to profile the sediment ranges. Reservoir capacity was determined using contour surface areas computed by the width-adjustment method. The original surface area of Angostura Reservoir in 1949 was 4,841 acres and the capacity was 159,919 acre-feet at the normal water surface elevation of 3,187.2 feet. The 1979 survey resulted in a surface area of 4,612 acres and a capacity of 130,768 acre-feet at the same normal water surface elevation. This indicated a loss of 29,151 acre-feet in capacity in the 29.6 years since the dam was built.
W85-05130

CABALLO RESERVOIR, 1981 SEDIMENTATION SURVEY,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
J. M. Lara.
Available from the National Technical Information Service, Springfield, VA 22161. March 1984. 50 p, 48 Fig, 3 Tab, 3 Ref.

Descriptors: *Reservoir silting, *Sedimentation, *Reservoir surveys, *Reservoir capacity, Silting, Sonar, Sediment distribution, *Caballo Reservoir, *New Mexico, Rio Grande.

Caballo Reservoir, New Mexico was surveyed in 1981 to compile field data needed to compute the reservoir capacity. The data were used to compute the volume of sediments that had accumulated in the reservoir since the gates of the dam were closed in 1938. Sonic depth recording equipment interfaced with an automated survey system was used to run the bathymetric survey. Reservoir capacity was computed based on surface areas determined by a width adjustment method. Reservoir capacity is 331,510 acre-feet; it has a surface area of 11,532 acres. Since 1938, sediments accu-

mulated to a volume of 15,226 acre-feet and result in a 4.4% of loss of reservoir capacity.
W85-05134

CALCULATION OF COARSE BED-LOAD MOVEMENT,
K. Stelczer.
Water Resources, Vol. 11, No. 1, p 1-6, January-February, 1984. 3 Fig, 12 Tab, 17 Ref. Translated from Vodnye Resursy, No. 1, p 3-9, January-February, 1984.

Descriptors: *Sediment transport, *Bed load, *Hungary, *Mathematical equations, Sediment, Flow velocity, Channel morphology, Sediment load, Sedimentation.

Methods used in Hungary to calculate sediment movement are reviewed. Emphasis is placed on the main factors affecting bed-load movement, the concept of bed-load movement, bottom flow velocity, size of sediment particles, depth of flow, slope of the channel bottom, the quality of the channel deposits, channel roughness, a characterization of the critical state by means of stochastic relations, and a determination of the virtual velocity of sediment movement. (Baker-IVI)
W85-05143

EXPERIMENTAL INVESTIGATION OF BED-LOAD DISCHARGE,
V. A. Vazilevich.
Water Resources, Vol. 11, No. 1, p 7-15, January-February, 1984. 7 Fig, 18 Ref. Translated from Vodnye Resursy, No. 1, p 10-19, January-February, 1984.

Descriptors: *Bed load discharge, *Sediments, *Mathematical equations, Bed load, Model studies, Scale models, Rivers, Channels, Shear stress, Velocity, Erosion, Sedimentation.

Bed-load discharge was measured during experiments on a large-scale model of a piedmont river channel. A distinctive feature of this model channel with a length of 58 m was that it included several large channel formations. As a result of analyzing various experimental dependences relating the bed-load discharge to characteristic parameters of the flow a functional relationship uniquely relating bed-load transport per unit width to the shear stress on the bottom was selected. The experimental values of the friction velocity on a given vertical of the flow were determined from the surface velocities measured by means of floats. As a result of this study and results from earlier experimentation equations are suggested for determining the bed-load discharge in the deposition and throughgoing zones and in erosion zones. Determination of the bed-load discharge by the relationships recommended shoud be performed in the following sequence: at first the discharge is calculated on the basis of the condition that erosion of the bed can occur in the given calculated stretch. If this calculated discharge is greater than the bed-load discharge arriving in the stretch from without, then erosion of the bed actually occurs here. Otherwise the sediment discharge must be recalculated on the basis of the condition that deposition sediments occur in the given calculated stretch and, having again compared it with the discharge of sediments arriving in the stretch from without, one determines precisely which of these two deformations occurs in the calculated stretch. (Baker-IVI)
W85-05144

MASS TRANSPORT IN THE TURBULENT BOTTOM LAYER OF A WAVE FLOW OVER A SLOPING BOTTOM,
I. O. Leont'ev.
Water Resources, Vol. 11, No. 1, p 15-20, January-February, 1984. 3 Fig, 1 Tab, 8 Ref. Translated from Vodnye Resursy, No. 1, p 20-25, January-February, 1984.

Descriptors: *Sediment transport, *Turbulence, Waves, Flow, Mathematical equations, Boundary layers, Water circulation, Slopes.

Physical criteria determining the direction of movement of water masses near the bottom were established. A semiempirical model of a turbulent boundary layer in progressive gravity waves over a sloping bottom was constructed. It is assumed that the time averaged circulation of water has a steady character, that breaking of waves is absent, and outside the boundary layer the flow is irrotational. The results demonstrate that for short waves the existence of positive transport at the bottom is possible in a wider range of gradients than for long waves. An increase of the gradient and wave period promotes the development of outflow in the bottom layer. (Baker-IVI)
W85-05145

EQUATION OF SEDIMENT DISCHARGE OF A SLUMP TURBIDITY CURRENT IN A DEFORMABLE CHANNEL,
A. S. Devdariani, and T. M. Akivis.
Water Resources, Vol. 11, No. 1, p 32-37, January-February, 1984. 4 Fig, 15 Ref. Translated from Vodnye Resursy, No. 1, p 40-46, January-February, 1984.

Descriptors: *Sediment transport, *Turbidity currents, *Coastal waters, Mathematical equations, Channels, Continental margin.

Turbidity currents occasionally occurring on continental margins are examined. Atlantic-type margins fringing almost the entire Atlantic and Arctic Oceans, Mediterranean and Black Seas, and partially the Indian Ocean are the major areas of concern. On margins of this type the continental slope gradually passes downward to the more gentle continental rise, which in turn gradually joins the plains of the ocean floor. Submarine canyons similar to valleys of mountain rivers cut the continental slope. Three methods of approximation are used in the examination: linear for definitely increasing or decreasing functions; exponential for functions approaching a certain limit; and an approximation by a constant for functions about the form of which nothing is known at all. (Baker-IVI)
W85-05146

DETERMINATION OF VELOCITIES OF MASS MOVEMENT OF SEDIMENTS ON THE FORESHORE,
S. S. Pirumov, V. V. Sakvarelidze, and N. I. Chechelashvili.
Water Resources, Vol. 11, No. 1, p 55-61, January-February, 1984. 3 Fig, 1 Tab. 13 Ref. Translated from Vodnye Resursy, No. 1, p 68-75, January-February, 1984.

Descriptors: *Sediment transport, *Mathematical equations, *Velocity, *Mass wasting, *Foreshores, Gravity flow, River mouth, Submarine canyons, Shear, Slope, Sediment erosion, Cohesion.

In the mouth regions of rivers and at the heads of submarine canyons, where the slopes of the foreshore are greater than on adjacent stretches, gravity induced mass movement of sediment deposits can occur with considerable velocities. The movement of sediment accumulations is examined in the case of secular shrinkage and brittle fracture accompanied by liquefaction of the soil along the slip surface. In stretches with intense accumulation of silt or clay sediments the stability of the sediment is disturbed mainly due to an increase of its thickness as a result of sediment accumulation. Stability is disturbed instantaneously, as a result of which the cohesion coefficient in the vicinity of the slip surface can decrease considerably, which promotes sliding of the body with considerable velocities. In the coastal zone the slump moves along the path of just deposited sediments having smaller cohesion coefficients. In the case of the instantaneous formation of a slump its velocities can be considerable. Slumping can also occur as a result of secular shrinkage, leading to a gradual decrease of the yield stress. In these cases sliding occurs quite slowly and continues until the physical properties of the sliding body change qualitatively, which can lead to a considerable decrease of the cohesion coefficient during a short time interval and to an increase in the velocity of the slide. (Baker-IVI)
W85-05147

STUDY OF SEDIMENT TRANSPORT ROUTES ON THE BASIS OF DYNAMIC STRUCTURES OF BOTTOM SEDIMENTS,
V. A. Grossgeim, and I. L. Gerashchenko.
Water Resources, Vol. 11, No. 1, p 66-73, January-February, 1984. 5 Fig, 21 Ref. Translated from Vodnye Resursy, No. 1, p 88-95, January-February, 1984.

Descriptors: *Sediment transport, *Routing, *Bottom sediments, *Paleohydrology, Sedimentation, Model studies, Marine sediments, Water currents, Paleomagnetism, Gravity.

The major purpose in paleoceanologic reconstruction during explorations of certain mineral resources associated with terrigenous rocks is to determine the positions, boundaries, and origin of sand bodies-reservoirs. Reconstruction of paleocurrents is of particular importance. Reference is made only to bottom currents which transport the bulk of the sediment along the bottom of basins, including those of reservoir size. Several experiments have been made to be certain of the method of orienting cross-laminated structures of cores by means of paleomagnetism. The method of studying the orientation of cross-laminated structures is briefly reviewed. During the past 30-40 years dozens of reconstructions have been made worldwide. In all cases the arrows showing the direction of currents formed orderly systems correlating well with other types of investigations and with the regularities of sedimentation established to date. Bottom currents are regarded as a mechanism by which sediments entering basins as a result of gravity are transported from the shallow region to regions of maximum depths. Bottom-current reconstruction methods are not limited to a study of the orientation of the inclinations of series of cross-laminae. They can be reconstructed on the basis of the change in fauna, distribution of certain characteristic minerals, change in the degree of roundness of fragmental material, distribution of types of sediments, orientation of sand grains and elongated objects, and orientation of ridges on the surface of beds. (Baker-IVI)
W85-05148

LIMNOLOGICAL STUDIES IN A CROSS-SECTION OF THE MIDDLE REACH OF PARANA RIVER, II: CHARACTERISTICS AND TEMPORAL VARIATIONS OF SUSPENDED SEDIMENT GRANULOMETRY (ESTUDIOS LIMNOLOGICOS EN UNA SECCION TRANSVERSAL DEL TRAMO MEDIO DEL RIO PARANA, II: CARACTERISTICAS Y VARIACIONES TEMPORALES DE LA GRANOMETRIA DE LOS SEDIMENTOS SUSPENDIDOS),
Instituto Nacional de Limnologia, Santo Tome (Argentina).
M. L. Amsler, and E. C. Drago.
Revista de la Asociacion de Ciencias Naturales del Litoral, Vol. 15, No. 1, p 7-21, 1984. 3 Fig, 4 Tab, 21 Ref.

Descriptors: *Parana River, *Argentina, *Suspended sediments, *Granulometry, Silt, Clay, Particle size, Wash load, Flow discharge.

This paper deals with the granulometric characteristics and variation of suspended sediment at a cross-section of the middle reach of the Parana River. The frequency distributions of the mean diameters ranged between fine and very fine silts suggesting that suspended sediments are composed largely of wash load (in this case, particles finer than 31 micro-m). The concentration of particles peaked when the Bermejo River contributed its load with high percentages of clay size particles. During such times, the smallest mean diameters and the best sorting were detected. The rest of the time suspended loads were characterized by poorly sorted suspended materials and higher mean diameters within the fine silts range. Maximum mean diameters and the worst sorting were observed during special events: the highest discharge and low wash loads. It was attributed to an increase of the coarse suspended fractions. (Author's abstract)
W85-05173

LIMNOLOGICAL STUDIES IN A CROSS-SECTION OF THE MIDDLE REACH OF PARANA RIVER, III: SOLID COMPONENTS TRANSPORTED IN SUSPENSION (ESTUDIOS LIMNOLOGICOS EN UNA SECCION TRANSVERSAL DEL TRAMO MEDIO DEL RIO PARANA, III: COMPONENTES SOLIDOS TRANSPORTADOS EN SUSPENSION),
Instituto Nacional de Limnologia, Santo Tome (Argentina).
H. Bertoli de Pomar.
Revista de la Asociacion de Ciencias Naturales del Litoral, Vol. 15, No. 1, p 25-46, September, 1984. 3 Fig, 10 Tab, 18 Ref.

Descriptors: *Suspended solids, *Sediment transport, *Parana River, *Argentina, Silt, Clay, Minerals, Protozoans, Sponge spicules, Phytoliths, Silica.

This work was undertaken in order to determine the variability of concentrations, mineral associations and biogenic components of suspended solids transported by the Parana River through a cross-section of its middle reach. It has been established that total suspended solids concentrations varies between 33.7 and 893.4 mg/l according to the water discharges. The concentrations are not uniformly distributed in the water column, with a trend to increase towards the bottom. The silt-size mineralogy contains mainly metamorphic species and vitroclasts, with preponderance of quartz, followed by biotite, tourmaline, and zircon. The clay-size fraction is composed of variable proportions of illite, kaolinite, montmorillonite, and chlorite. The last two minerals are absent during low waters. Within the biogenic fraction, protists, demosponges spicules and Gramineae, Cyperaceae, Palmaceae, and Podostemaceae phytoliths were found. There is evidence that silt- and clay-sized minerals are supplied by Brazilian metamorphic sources, with lesser contributions from the mountainous Andean environment. Biogenic silicic particles are mostly authigenic, with the exception of Palmaceae and Podostemaceae phytoliths, contributed by the palm groves (Chaco-Corrients) and the upper Parana River respectively. (Author's abstract)
W85-05174

LIMNOLOGICAL STUDIES IN A CROSS-SECTION OF THE MIDDLE REACH OF PARANA RIVER, IV: INFLUENCE OF THE SUSPENDED SEDIMENT GRANULOMETRIC COMPOSITION ON WATER TRANSPARENCY (ESTUDIOS LIMNOLOGICOS EN UNA SECCION TRANSVERSAL DEL TRAMO MEDIO DEL RIO PARANA, IV: INFLUENCIA DE LA COMPOSICION GRANOMETRICA DE LOS SEDIMENTOS SUSPENDIDOS SOBRE LA TRANSPARENCIA DEL AGUA),
Instituto Nacional de Limnologia, Santo Tome (Argentina).
E. C. Drago.
Revista de la Asociacion de Ciencias Naturales del Litoral, Vol. 15, No. 1, p 47-55, September, 1984. 1 Fig, 1 Tab, 13 Ref.

Descriptors: *Parana River, *Argentina, *Suspended sediments, *Transparency, Granulometry, Sand, Clay, Silt.

This paper deals with the influence of suspended sediment granulometric composition on the transparency of Parana River water. Secchi disk measurements and the surface water samples were obtained every fifteen days from the center of the main channel from October 1976 to December 1977. The amount of sand in suspension did not influence water transparency, but clay and silt concentrations produced notable changes on Secchi disk measurements. The linear correlation coefficients, r, between transparency and clay and silt amounts were -0.83 ($p < 0.001$) and -0.76 ($p < 0.001$), respectively. The highest concentrations of clay and silt were supplied by the Bermejo Paraguay rivers system while the Alto Parana River supplied the reddish suspended matter ('red wave'). Both these sources remarkably changed water transparency in the Parana. (Author's abstract)
W85-05175

LIMNOLOGICAL STUDIES IN A CROSS-SECTION OF THE MIDDLE REACH OF PARANA RIVER, V: TEXTURAL FEATURES OF BED SEDIMENTS (ESTUDIOS LIMNOLOGICOS EN UNA SECCION TRANSVERSAL DEL TRAMO MEDIO DEL RIO PARANA, V: CARACTERES TEXTURALES DE LOS SEDIMENTOS DE FONDO),
Instituto Nacional de Limnologia, Santo Tome (Argentina).
H. B. de Pomar.
Revista de la Asociacion de Ciencias Naturales del Litoral, Vol. 15, No. 1, p 57-78, September, 1984. 15 Fig, 5 Tab, 23 Ref.

Descriptors: *Parana River, *Argentina, *Bed sediments, Sediment texture, Saltation, Leptocurtosity, Clay, Silt, Sorting, Sediment transport, Velocity.

This work was undertaken to go one step farther in the knowledge of the Parana River limnological aspects. It deals with the textural features of the bed sediments 2.7 km northern Parana City, Entre Rios, Argentina, at a primary control section. The observed variations during a sampling period of 5 years indicate that particles up to phi 2 are transported. The sediment features are as follows: a) At the center of the river medium to fine sands occur, with saltation population prevailing at phi 2 (x : 95%), well to very well sorted (sigma sub 1: 0.37), with unimodal symmetric distribution and leptocurtosity. b) Near the river edges clay silt occur, with phi 5 predominant (coarse silt), without traction population, 66% of saltation population, poorly sorted, positive bimodal distribution and leptocurtosity. This last textural parameter was the only coincident in the granometric distributions of the three sampling stations. Sorting did not fit within limits given in previous studies for fluvial sediments. Bottom current velocity is the principal factor affecting variation of transport and depositional processes. (Author's abstract)
W85-05176

EFFECT OF SLOPE AND RAINFALL INTENSITY ON EROSION FROM SODIUM DISPERSED, COMPACTED EARTH MICRO-CATCHMENTS,
Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.
For primary bibliographic entry see Field 3B.
W85-05191

EFFECT OF FURROW IRRIGATION EROSION ON CROP PRODUCTIVITY,
Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center.
For primary bibliographic entry see Field 6G.
W85-05192

SEDLAB: THE HYDROLOGY/SEDIMENT TRANSPORT MODEL OF THE USDA SEDIMENTATION LABORATORY,
For primary bibliographic entry see Field 2A.
W85-05341

SCOUR CONTROL AT OUTLOOK BRIDGE - A CASE STUDY,
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
C. D. Smith.
Canadian Journal of Civil Engineering, Vol. 11, No. 4, p 709-716, December, 1984. 10 Fig, 3 Ref.

Descriptors: *Scour, *Outlook Bridge, *Saskatchewan, *Erosion control, *Bridges, Footings, Flood protection, Flood damage, Abutments, Costs.

The traffic bridge across the South Saskatchewan River at Outlook, Saskatchewan was completed in 1936. A low flood plain extends into the channel from the east bank. In order to shorten the total span for the bridge, an approach fill 260 m long was run out over the flood plain and the east abutment was located at the end of the fill. In the late 1940s the highway grade between the wings of the U-shaped abutment subsided. By the 1950s it was necessary to periodically top the highway grade with fill at the east abutment to maintain the grade profile at the entrance to the bridge. In January of 1951 12,000 bags filled with sand-cement were placed around the entire east abutment and timber piles were driven upstream across the front of the sandbags. During the 1951 spring flood the barrier was destroyed, all the sandbags except those on the downstream side of the abutment were lost, the scour went 5 m below the footing, and a hole developed in the roadway. Model tests conducted in 1956 indicated that abutment scour could be controlled with an earthguide bank, a 30 m cellular sheet pile guide wall, or with abutment riprap alone. Due to cost factors, it was decided to use riprap and in 1957 riprap was placed at the abutment. Sufficient riprap was added to bring the surface up to the normal bed elevation, 5 m above the footing, in the immediate vicinity of the abutment. About 3000 cu m of riprap was placed at a cost of $21,000. The most recent sounding in June of 1981 showed no change in riprap position, and the deepest scour in the east span was at the level of the footing 14 m out from the abutment. (Baker-IVI)
W85-05454

STABILITY AND SETTLING OF SUSPENDED SOLIDS IN SETTLING PONDS. PART II. DIFFUSION ANALYSIS OF INITIAL SETTLING OF SUSPENDED SOLIDS,
McGill Univ., Montreal (Quebec). Geotechnical Research Centre.
R. N. Yong, and D. Elmonayeri.
Canadian Geotechnical Journal, Vol. 21, No. 4, p 644-656, November, 1984. 18 Fig, 1 Tab, 24 Ref. Natural Sciences and Engineering Research Council of Canada grant A-882.

Descriptors: *Suspended solids, *Settling basins, *Wastewater treatment, *Diffusion, Model studies, Diffusion analysis, Stability, Sedimentation, Fines thickening.

The initial settling behavior of the low solids concentration suspensions is examined and analyzed to provide information on sedimentation characteristics and distribution of solids concentration profiles with them. The initial settling by self-diffusion of the suspended solids is first validated with controlled laboratory experiments and then applied to evaluate test results obtained in another lab. The method of analysis is further applied to one settling pond for prediction of settling rate and distribution of solids in the pond in the initial settling stages. In evaluations of the settling characteristics and performance of suspended solids in settling columns or ponds several choices must be made ranging from specific consideration of molecular or microscopic activity to macroscopic particle or solids settling theories where gravity-drive mechanisms dominate. The intermediate position between a complete microscopic examination and the total gravity-drive system was used. The diffusion-convection model has ben adopted and examined in terms of relative fluxes established between the downward motion of the suspended solids and the upward movement of water. The diffusion convection model developed here on the basis of relative flux holds promise as a tool in analysis and prediction. The problem addressed is one where the initial solids concentration in suspension is low and were no measurable pore pressures are obtained. This is the condition that is typical of the initial settling phase of suspended solids on its way to formation of a sediment layer. (Baker-IVI)
W85-05527

QUANTITATIVE ANALYSIS OF DEBRIS TORRENT HAZARDS FOR DESIGN OF REMEDIAL MEASURES,
Thurber Consultants Ltd., Vancouver (British Columbia).
O. Hungr, G. C. Morgan, and P. Kellerhals.
Canadian Geotechnical Journal, Vol. 21, No. 4, p 663-677, November, 1984. 11 Fig, 3 Tab, 41 Ref.

Descriptors: *Erosion control, *Prediction, *Debris torrents, Storms, Slopes, Landslides, Design criteria, Water management, Mass wasting, Channels, Bridges, Debris retention barriers.

A first attempt at quantitative prediction of debris torrent behavior in Canada is detailed. Design of debris torrent remedial measures in other countries relies heavily on site-specific experience of long duration, sometimes of several centuries. Such experience is not available in Canada. Attempts were made to combine theoretical understanding of the phenomenon with detailed observations, to obtain a semiempirical design method. This 2 year study involved hazard risk assessment and has resulted in the design of a comprehensive system of remedial measures comprising debris retention barriers and basins, channel improvements, and diversions, and the reconstruction of bridges. New design procedures were needed to cover the dynamic behavior of debris torrents. An approach is offered for determining magnitude (volume of debris material involved), frequency, peak discharge, velocity, conditions for deposition, runout distance, behavior in bends and run-up against barriers, and dynamic thrust and impact loadings. The procedures are based on some of the more practical concepts available in the specialized literature. Wider and more thorough calibration is required before the procedure can enjoy a more general acceptance. (Baker-IVI)
W85-05529

CHANNEL-FILL DEPOSITS FORMED BY AGGRADATION IN DEEPLY SCOURED, SUPERIMPOSED DISTRIBUTARIES OF THE LOWER KOOTENAI FORMATION (CRETACEOUS),
Calgary Univ. (Alberta). Dept. of Geology and Geophysics.
J. C. Hopkins.
Journal of Sedimentary Petrology, Vol. 55, No. 1, p 42-52, January, 1985. 12 Fig, 36 Ref.

Descriptors: *Channel morphology, *Sedimentation, *Aggradation, Scour, Diversion, Distributaries, Channel-filling.

Three large channels of the lower Kootenai Formation are exposed in the walls of the Missouri River valley east of Great Falls, Montana. Although the channels occur in two different stratigraphic units, they have several features in common. Each channel is contained within crevasse and bay-fill sequences, but the contacts between channel-fill deposits and laterally adjacent strata are erosional. The channels have a broad U-shape, range up to 300 m wide and 35 m deep, and exhibit a distinctive style of fill. Channel-filling occurred in increments by accretion from the bottom up and sides in, to form a concave layering which is more or less symmetrical about the axis of each channel. Lithology of the fill channel is quite different, however, and ranges from mudstone, to interbedded sandstone and mudstone, to sandstone. The channels are interpreted as superimposed distributaries formed by avulsion when the locus of sedimentation shifted from one lobe to another. The lithology of the channel-fill deposits appears to a be a function of the abandonment rate. A mudstone-filled channel results where abandonment is rapid, as in the case with upstream diversion of a trunk river system. Sandstone and mixed sandstone-mudstone fills predominate where a distributary is progressively abandoned, for example, where the discharge is diverted into an alternately favored distributary. Superimposed channels are difficult to map in the subsurface by geologic means. They cut across the trend of adjacent facies, and so their presence cannot be predicted from analysis of the containing strata. (Author's abstract)
W85-05617

ORIGIN OF SHAPE CHANGES OF SAND AND SILT IN A HIGH-GRADIENT STREAM SYSTEM,
South Carolina Univ., Columbia. Dept. of Geology.
S. K. Kennedy, and R. Ehrlich.
Journal of Sedimentary Petrology, Vol. 55, No. 1, p 57-64, January, 1985. 5 Fig, 2 Tab, 14 Ref.

Descriptors: *Sand, *Silt, *Particle shape, *Stream gradient, Sedimentary petrology, Shape, Petrology, Particle size, Sediment transport.

Changes in shape of sand and silt in streams may be a reflection of changes in source rock rather than the progressive effects of transport. If so, shape characteristics should change as the stream crosses geologic contacts. To clarify the problem, stream sediment samples were collected in two drainage basins on the west flank of the Bighorn Mountains, Wyoming. Three size fractions - fine sand, very fine sand, and coarse silt - were studied using Fourier analysis and the scanning electron microscope. Provenance discrimination improves with increasing grain size. In all three size ranges sediment derived from a glaciated crystalline rock source can be differentiated from the derived from sedimentary rock sources. Sand from sedimentary rock sources can be subdivided into shape families according to the extent of diagenesis. In very fine sand and fine sand, sediment from the Flathead Sandstone is distinguishable from that derived from other sedimentary rocks. In fine sand the Tensleep and Darwin sandstones are also distinguishable as separate sources. Along Tensleep Creek, changes in the shape composition of sediment occur rather continuously due to transport of sediment by past glacial processes. Along Paintrock Creek, however, shape proportions do not change in a continuous manner but instead change by abrupt, discrete jumps which occur where additional sources provide sediment. The shape changes are due to the dilution of upstream sediment by sediment from adjacent sources. This suggests that downstream sources provide sediment at a greater rate than the upstream sources even though the gradient decreases with distance. This can be explained by the fact that the younger, downstream sedimentary rocks are more friable than the upstream rocks. (Author's abstract)
W85-05618

ANNUAL SEDIMENT ACCMULATION AND LAND USE HISTORY; INVESTIGATIONS OF VARVED LAKE SEDIMENTS,
Umea Univ. (Sweden). Dept. of Ecological Botany.
U. Segerstrom, I. Renberg, and J.-E. Wallin.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1396-1403, December, 1984. 7 Fig, 9 Ref.

Descriptors: *Sedimentation, *Lake sediments, *Varves, *Sweden, Lakes, Annual distribution, Land use, History, Organic matter, Agriculture, Eutrophication.

Four lakes in northern Sweden, all of them having varved sediments, were investigated. The annual deposition rate of organic and mineral matter was calculated. Changes in vegetation and the history of land use have been studied mainly by pollen analysis. An increase in the annual deposition of both organic and mineral matter has occurred due to land use. The changes in deposition become especially striking during the period of agricultural expansion that has taken place in the 19th and 20th century. The organic deposition has increased by about 100% and the deposition of inorganic matter has increased by about 150-200% during the last 200 years. Eutrophication causing higher production in the lakes and/or erosion and subsequent supply of allochthonous material into the lakes seem to be the most possible reasons for these changes. (Baker-IVI)
W85-05627

PHOSPHORUS COMPOUNDS IN THE SEDIMENT OF THE SAU RESERVOIR (BARCELONA, NE SPAIN) THROUGHOUT ITS TWENTY-YEAR EXISTENCE,
Barcelona Univ. (Spain). Dept. de Ecologia.
For primary bibliographic entry see Field 2H.
W85-05638

ECOLOGICAL INVESTIGATIONS ON THE ALLUVIAL SEDIMENTS OF THE DANUBE IN THE VIENNA AREA - A PHREATOBIOLOGICAL PROJECT,
Oesterreichische Akademie der Wissenschaften, Vienna. Inst. fuer Limnologie.
D. L. Danielopol.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1755-1761, December, 1984. 2 Fig, 3 Tab, 17 Ref.

Descriptors: *Alluvial sediments, *Interstitial fauna, *Danube River, *Austria, Sediments, Seasonal variation, Groundwater, Water quality, Interstitial water.

Because of the construction over the past few years of several hydroelectric power stations on the Danube there is an urgent need to preserve the groundwater reserves at the high standard required for a potable supply. A seasonal sampling program was performed in 1980. Interstitial fauna was collected and groundwater extracted from fixed standpipes placed at different depths in the alluvial sediments. The fauna of the bed sediments of a backwater of the Danube, Lobau Eberschuttwasser are delineated along with the fauna in the gravel bar sediments of the Danube near the river March. The alluvial sediments of the March bar and of the backwater Eberschuttwasser represent zones of the input/output areas of the Danube groundwater ecosystem. The superficial alluvial sediments remained unclogged in both cases. In the case of the gravel bar March, the superficial sediments are maintained far from equilibrium due mainly to physical disturbances. It appears that the interstitial fauna plays a minor role in the preservation of an open interstitial system. The opposite occurs in the alluvial sediments of the backwater Ebershuttwasser, where the interstitial environment is subject to less physical stress. In the upper layers of these sediments some of the animals which develop abundantly and persistently, contribute to the pelletization of the silty sediment which accumulates in the sand and gravel matrix. Their activity is considered to represent a type of biological disturbance which helps to preserve the free circulation of water and organic matter inside and outside the groundwater system. The groundwater fauna plays, in some cases, an important role in the functioning of a groundwater ecosystem. (Baker-IVI)
W85-05656

ANALYSIS OF THE PROCESS OF RETENTION OF ORGANIC MATTER IN STREAM ECOSYSTEMS,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
R. Speaker, K. Moore, and S. Gregory.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1835-1841, December, 1984. 3 Fig, 1 Tab, 6 Ref.

Descriptors: *Sediment transport, *Ecosystems, *Streams, *Organic matter, Riparian vegetation, Riparian waters, Channels, Decomposing organic matter, Particulates, Sediments, Lotic environments, Debris dams.

Lotic ecosystems are substantially different from most other ecosystems as the continuous unidirectional flow through the system tends to transport matter to downstream reaches. The process of retention removes matter from transport and makes it available for utilization by stream biota, thus providing a critical link between input and storage. A method is described for the quantitative assessment of retention of particulate organic matter in streams and several major stream retention features are identified that can be influenced by the structure and composition of riparian zones. This study focuses on short-term retention processes on streams and does not address long-term patterns of storage. The retention of leaves was measured in the Cascade Mountain Range of Oregon using reaches of 50 m to represent the geomorphic structural diversity. Leaf retention curves conformed well to a negative exponential model. Though leaves were retained at fairly uniform rates at many sites, the presence of wood debris dams had a major influence on reach retention patterns. Retention structures differed greatly in their relative efficiency of trapping leaves. Rates of retention were closely related to general hydrological and structural characteristics of the study reaches. Leaf retention rates were greater in

reaches with higher ratios of wetted perimeter to channel cross-sectional area. (Baker-IVI)
W85-05664

ROLE OF WOOD DEBRIS IN MODIFYING CHANNEL GEOMORPHOLOGY AND RIPARIAN AREAS OF A LARGE LOWLAND RIVER UNDER PRISTINE CONDITIONS: A HISTORICAL CASE STUDY,
Geological Survey, Menlo Park, CA.
F. J. Triska.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1876-1892, December, 1984. 7 Fig, 4 Tab, 54 Ref.

Descriptors: *Channel morphology, *Geomorphology, *Riparian areas, *History, *Debris, *Red River, *Louisiana, Wood wastes, Lakes, Alluvial deposits, Debris dams, Floods, Snags.

Historical records were reviewed to estimate the impact of wood debris on a 400-500 km reach of the Red River, Louisiana. In the primal condition the banks consisted of unstable alluvial deposits easily eroded during floods. Sediment and riparian trees from eroded banks formed organic debris dams which blocked the channel and promoted channel aggradation. Over a period > 375 years wood debris dams formed in series. The longest instantaneous length of impacted channel was 225 km. The average rate of channel blockage was 1.3 to 1.6 km/year between 1793-1876. Maximum debris accumulation recorded in a single flood was 8.1 km. Exposed wood covered 80-120 km of channel. Debris dams remained in place 80-150 years. Wood debris impacted adjacent riparian areas by flooding forests and forming a series of large lakes. Under natural conditions lakes could become nearly permanent features of the riparian landscape if tributary channels filled with alluvium and organic debris. After removal of organic debris the most recently formed lakes drained over a period of approximately 30 years. Flow reversal in tributaries resulted in channel enlargement and diversion of one half to three quarters of the river's discharge adjacent to riparian lowlands. Wood debris reduced the river's width from about 185 m to approximately 40 m, and aggraded the river bed a maximum of 7 m. Tributary channels were dammed or filled with organic debris, and the river was permanently opened to navigation in 1873. Restoration of full channel flow exposed previously buried logs and eroded forested banks. By 1904, seventy years of debris dams and snag removal, levee projects, dredging and cutting bankside trees resulted in a cleared, wide, meandering channel, which might today be mistaken as typical of a pristine lowland river. (Baker-IVI)
W85-05668

SESTON TRANSPORT IN STREAMS AT COWEETA HYDROLOGIC LABORATORY, NORTH CAROLINA, U.S.A.,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
J. R. Webster, and S. W. Golladay.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1911-1919. December, 1984. 5 Fig, 2 Tab, 22 Ref. DOE contract W-7405-eng-26, NSF grant DEB 8012093.

Descriptors: *Seston transport *Streamflow, *North Carolina, Seston, Streams, Organic carbon, Catchments, Environmental effects, Seasonal variation.

Seston was collected from a variety of small streams at Coweeta Hydrologic Laboratory, North Carolina in order to better understand mechanisms determining seston transport and examine the effect of catchment disturbance on seston concentrations during non-storm periods. Based on samples taken over a six year period from catchment 14 (C14), non-storm organic seston concentrations peaked in summer and were lowest in winter. Seasonal patterns in seston concentration are due in part to dilution because maximum non-storm discharge usually occurs in late winter-early spring and minimum discharge usually occurs in autumn. Highest transport occurred in spring, and transport was lowest during autumn. However, there was no relationship between organic seston concentration and discharge for samples taken from C14 during non-storm periods. Inorganic (ash) seston concentration exhibited the same seasonal pattern and could not be related to discharge during non-storm periods. The per cent ash in seston was very consistent over different dates and discharges. Statistically significant downstream increases in both organic and inorganic seston concentrations in C14 were found. The downstream increase was greatest near the source. There was no statistically significant change in per cent ash downstream from the source. Catchment disturbance resulted in significant differences among organic and inorganic seston concentrations and per cent ash in the seston of the twelve streams. Organic and inorganic seston concentrations and per cent ash were highest for streams draining the two most recently disturbed catchments, and were lowest for the two catchments which have had the longest time to recover and which were disturbed the least. (Baker-IVI)
W85-05671

SEDIMENTATION RATES AND HEAVY METAL POLLUTION OF SEDIMENTS IN THE SETO INLAND SEA, PART 3, HIUCHI-NADA,
Government Industrial Research Inst., Kyushu, Tosu (Japan).
For primary bibliographic entry see Field 5B.
W85-05687

FRACTIONATION OF ORGANIC AND INORGANIC PHOSPHORUS COMPOUNDS IN LAKE SEDIMENTS, AN ATTEMPT TO CHARACTERIZE ECOLOGICALLY IMPORTANT FRACTIONS (DIE FRAKTIONIERUNG ORGANISCHER UND ANORGANISCHER PHOSPHORVERBINDUNGEN VON SEDIMENTEN, VERSUCH EINER DEFINITION OKOLOGISCH WICHTIGER FRAKTIONEN),
Innsbruck Univ. (Austria).
For primary bibliographic entry see Field 2H.
W85-05728

SAPPING PROCESSES AND THE DEVELOPMENT OF THEATER-HEADED VALLEY NETWORKS ON THE COLORADO PLATEAU,
California Inst. of Tech., Pasadena. Guggenheim Jet Propulsion Center.
J. E. Laity, and M. C. Malin.
Geological Society of America Bulletin, Vol. 96, No. 2, p 203-217, February 1985. 13 Fig, 42 Ref. NASA grants NAS7-100 and NAGW-1.

Descriptors: *Sapping, *Theater-headed valleys, *Groundwater erosion, *Glen Canyon, *Utah, Erosion, Drainage systems, Overland flow, Groundwater movement, Seepage, Mars, Geomorphology.

Ground-water sapping is an erosional process that produces landforms with unique characteristics. Sapped drainage systems differ in morphology, pattern, network spatial evolution, rate of erosion, and degree of structural control from their fluvial counter-parts. Investigation of deeply entrenched theater-headed valleys in the Glen Canyon region of the Colorado Plateau indicates that groundwater sapping is the predominant mechanism of growth. The canyons occur in the Navajo Sandstone, a highly transmissive aquifer underlain by essentially impermeable rocks. Within this formation, two populations of valleys with markedly different features are identified. The first group exhibits theater heads: longitudinal profiles with high, steplike discontinuities and commonly asymmetric, structurally controlled patterns. The second group is characterized by tapered terminations; a relatively smooth, concave-up profile; and a more arborescent network. Because the valleys have developed under the same lithologic, stratigraphic, and climatic conditions, the differences in form are attributed primarily to structural constraints that determine the relative effectiveness of overland-flow and ground-water (sapping) processes. Of particular importance is the dip direction of the beds relative to that of valley growth, inasmuch as this relationship controls the occurrence and distribution of ground-water seepage at valley walls. Laterally flowing ground water also exploits fractures at depth, so that the drainage pattern of theater-headed valleys reflects that of the regional jointing pattern. Martian valleys exhibit numerous morphologic similarities to canyons formed in the Navajo Sandstone. These include theater-shaped heads, nearly constant width from source to outlet, high and steep sidewalls, hanging outlets, and a large degree of structural control. Although the constituent materials, scale, climate, structure, and groundwater conditions of Mars cannot be replicated in any Earth analog, the striking similarities in form suggest that the gross geomorphic processes may be similar and that sapping processes have operated to create the Martian valleys. (Author's abstract)
W85-05729

BED MICROTOPOGRAPHY AND ENTRAINMENT THRESHOLDS IN GRAVEL-BED RIVERS,
BP Exploration Co. Ltd., London (England). Sedimentology Branch.
A. C. Brayshaw.
Geological Society of America Bulletin, Vol. 96, No. 2, p 218-223, February, 1985. 4 Fig, 1 Tab, 32 Ref.

Descriptors: *River beds, *Microtopography, *Entrainment, *Gravel-bed rivers, *Bed load, Clasts, Velocity, Sediment transport, Flood flow.

Although increasingly acknowledged as an important factor in bedload transport, few data on the effects of bed conditions on entrainment in gravel-bed rivers exist. This reflects to some degree the substantial difficulties involved in obtaining accurate threshold measurements in such channels. Using a sensor which allows initial movement of labeled particles to be detected during flood flow, the entrainment thresholds of clasts incorporated into the bed microtopography have been compared with those in exposed, open plane-bed positions. The threshold velocity of clasts from cluster bedforms, the most prevalent type of bed microtopography, is found to be above that of more exposed particles of like size and shape. Measurements indicate that the initial movement of approximately 70% of particles in gravel-bed rivers will be directly influenced by the presence of neighboring grains. Bed microtopography plays an important role in delaying incipient motion. The influence of microtopography may be invoked to account for phenomena such as discontinuous particle movement and variations in the composition of bedload during discharge events. (Author's abstract)
W85-05730

CHANNEL SCOURING POTENTIAL USING LOGISTIC ANALYSIS,
Wyoming Water Research Center, Laramie.
For primary bibliographic entry see Field 2E.
W85-05779

FREE JET SCOUR BELOW DAMS AND FLIP BUCKETS,
Gibb (Alexander) and Partners, London (England).
For primary bibliographic entry see Field 8B.
W85-05781

SALT RIVER CHANNELIZATION PROJECT: MODEL STUDY,
Simons, Li and Associates, Inc., Fort Collins, CO.
Y. H. Chen, A. A. Fiuzat, and B. R. Roberts.
Journal of Hydraulic Engineering, Vol. 111, No. 2, p 267-283, February, 1985. 8 Fig, 4 Tab, 7 Ref.

Descriptors: *Salt River, *Phoenix, *Arizona, *Channelization, *Model studies, Fixed bed models, Movable bed models, Bank erosion, Erosion, Deposition.

A channelization project proposed for the Salt River in Phoenix, Arizona, would contain flood flows and eliminate future damage to the adjacent Sky Harbor International Airport - a severe flood in 1979 heavily damaged the facility. Two models

were tested in order to determine the adequacy of the channelization scheme. The model's flume is 36.5 m long, 12.2 m wide and 1.1 m deep; discharges of up to 100 cfs may be routed through the flume. One fixed-bed model was used to study velocity patterns, flow stages, bank freeboards and bank protection requirements. One distorted movable-bed model was utilized to study erosion and deposition patterns and bank stability in the proposed scheme. Incipient motion of bed particles and tractive force theory for stability of banks were utilized for modeling the various complicated parts of the movable-bed model. Good agreement was observed when results were compared with mathematical model results. (Collier-IVI)
W85-05783

2K. Chemical Processes

CHEMICAL COMPOSITION OF RAIN WATER WITH SPECIAL REFERENCE TO HEAVY METALS OVER LUCKNOW, UTTAR PRADESH IN 1981,
Central Ground Water Board, Lucknow (India). Central Chemical Lab.
B. K. Handa, A. Kumar, and D. K. Goel.
Mausam, Vol. 35, No. 2, p 235-237, April, 1984. 5 Tab, 7 Ref.

Descriptors: *Rain, *Chemical composition, *Lucknow, *India, Acidity, Sodium, Potassium, Calcium, Chlorides, Carbonates, Trace elements, Heavy metals.

Rain water samples were collected in 1981 and analyzed for various constituents, including trace elements by standard methods. There was no acid rain found over Lucknow. However the EC of rain water showed considerable variation, ranging between 3 and 118 microsiemens/cm. The phosphate and ammonia concentrations in rain water ranged around 0.298 mg/l and 0.66 mg/l, respectively. Concentrations of trace elements varied considerably with no direct relation being observed between quantity of rainfall and trace element concentration. Iron was the most abundant trace element, mean 30.9 mg/l. Origins for the various constituents in the rainwater include sea salt nuclei, volatile constituents from stagnant water bodies, mining activities, waste incineration, agricultural activities which include aerial spraying of insecticides, forest fires, fossil fuel burning, automobile emissions, soil dust particles, and exudation of heavy metals by vegetation. (Baker-IVI)
W85-05101

SOLUBILITIES AND SUPERSATURATIONS OF CALCIUM SULFATE AND ITS HYDRATES IN SEAWATER,
Technische Hogeschool, Delft (Netherlands). Dept. of Chemical Engineering and Chemistry.
For primary bibliographic entry see Field 3A.
W85-05114

HYDROGEOLOGIC AND GEOCHEMICAL STUDIES OF SELECTED NATURAL RADIOISOTOPES AND BARIUM IN GROUNDWATER IN ILLINOIS,
Illinois State Geological Survey Div., Champaign.
R. H. Gilkeson, K. Cartwright, J. B. Cowart, and R. B. Holtzman.
Illinois Geological Survey Report No. 1983-6. May 1983. 93 p, 13 Fig, 3 Tab, 60 ref. Project No. OWRT B-108-ILL.

Descriptors: *Radioisotopes, *Groundwater, *Barium, *Radium radioisotopes, *Uranium radioisotopes, *Bedrock, Aquifers, Geohydrology, Drinking water, Chemical properties, Sulfates, Minerals, Northern, Northern Illinois, Water quality.

Dissolved concentrations of the natural radioisotopes Rn222, Ra226, Ra228, Th230, Th232, U234, and U238 and the element Ba(2+) were investigated in a study of high concentrations of Ra226, Ra228, and Ba(2+) in groundwater from the Cambrian and Ordovician bedrock of northern Illinois. The high radium and barium concentrations are naturally present in the major aquifers--the sandstone bedrock; therefore, remedial well construction measures will not lower the concentrations. The combined concentrations of Ra226 and Ra228 range from 2.3 to 50.2 picocurie/liter; the majority of analyses exceed the limit in the drinking water regulations of 5.0 picocurie/liter. The Ra226/Ra228 activity ratio ranges from 0.2 to 41.0; a Ra226 analysis has no validity for predicting the Ra228 concentration. Important controls on dissolved Ra226 concentrations are secondary U on the sandstone matrix and the ionic strength of groundwater. The distribution of accessory minerals that contain Th232 is believed to be an important control on dissolved Ra228 concentrations. Locally the dissolved Ra226 and Ra228 concentrations are affected by dissolution-precipitation of secondary barite. Dissolved concentrations of Rn222 and U are less than proposed drinking water regulations. The extreme enrichment in U234 that occurs widespread in groundwater from the Cambrian and Ordovician bedrock is unique and problematic. The enrichment may reflect recharge of uranium to the bedrock by glacial processes. Dissolved Ba(2+) concentrations range from < 0.0 to 22.4 milligrams/liter. The high Ba(2+) concentrations occur in groundwater that is depleted in dissolved SO4(2-) by anaerobic microbial reactions.
W85-05122

USE OF URANIUM-SERIES ISOTOPES FOR STUDYING THERMAL WATERS OF THE FRUNZE REGION,
For primary bibliographic entry see Field 2F.
W85-05150

ISOTOPE INVESTIGATIONS OF THE CONDITIONS OF FORMATION OF MINERAL AND THERMAL WATERS IN SOME CAUCASIAN REGIONS,
For primary bibliographic entry see Field 2F.
W85-05152

MODELING OF CO2 DYNAMICS IN A BODY OF FRESHWATER,
For primary bibliographic entry see Field 2H.
W85-05159

EFFECT OF CATION EXCHANGE ON CALCULATED HYDRODYNAMIC DISPERSION COEFFICIENTS,
Guelph Univ. (Ontario). Dept. of Land Resource Science.
For primary bibliographic entry see Field 2G.
W85-05183

CHARACTERIZATION OF WATER FROM LAVERKIN SPRINGS, UTAH,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
R. J. Eisenhauer.
Available from the National Technical Information Service, Springfield, VA 22161. Report REC-ERC-83-3. April 1983. 40 p, 4 Fig, 30 Tab, 3 Ref, 1 Append.

Descriptors: *Water analysis, *Chemical properties, *Water quality, *Springs, *Saline water intrusion, *Saline water, Salinity, Trace elements, Colorado River, Salts, Boreholes, Calcium, Magnesium, Potassium, Sodium, Dissolved solids, Utah, Groundwater movement, Groundwater, Washington County.

Water from the LaVerkin Springs (LVS) which discharge into the Virgin River, a tributary of the Colorado River, has been studied since 1971 by the Bureau of Reclamation as part of the Colorado River Water Quality Improvement Program. The 1972 and 1979 to 1980 LVS water analyses data were reevaluated and compared to evaluate uniformity of water analysis from each of the 14 springs, monthly variations in spring water analyses, differences between spring water and borehole water analyses, characteristics of spring water, and differences between the 1972 and 1979 to 1980 spring water analyses. The analyses of water taken from 10 of the 14 springs in 1972 suggest that the water issuing from each spring comes from the same source. Throughout the 1972 tests, dissolved Ca, Mg, K and Na salt concentration varied < +/- 5% from the average values. The average value of total dissolved solids (TDS) was was 9770 milligrams/liter and remained constant at 9800 milligrams/liter during January through May. The TDS dropped to a low of 9670 milligrams/liter in June but gradually returned to 9800 milligrams/liter by December. The water from all of the springs and the borehole seemed to come from the same source. The spring water tested in 1972 and again in 1979-1980 had comparable average values of Ca, Mg, K, sodium bicarbonate, chloride, and sulfate dissolved salts. The average values of dissolved salts for the two test periods compared within the variations expected from sampling and analytical errors.
W85-05309

REGIONAL SURVEY OF CHEMISTRY OF HEADWATER LAKES AND STREAMS IN NEW ENGLAND: VULNERABILITY TO ACIDIFICATION,
Columbia National Fisheries Research Lab., Orono, ME. Field Research Station.
For primary bibliographic entry see Field 2H.
W85-05312

ATMOSPHERIC TRAJECTORY MODELS FOR DIAGNOSING THE SOURCES OF ACID PRECIPITATION,
Michigan Univ., Ann Arbor. Dept. of Atmospheric and Oceanic Science.
For primary bibliographic entry see Field 5B.
W85-05314

NORWEGIAN MODELS FOR SURFACE CHEMISTRY: AN OVERVIEW,
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 2A.
W85-05317

MODELING THE REACIDIFICATION RATES OF NEUTRALIZED LAKES NEAR SUDBURY, ONTARIO,
Ontario Ministry of the Environment, Rexdale. Water Resources Branch.
For primary bibliographic entry see Field 2A.
W85-05319

MODELING IMPACTS OF ACID PRECIPITATION FOR NORTHEASTERN MINNESOTA,
Iowa Univ., Iowa City. Div. of Energy Engineering.
J. L. Schnoor, W. D. Palmer, and G. E. Glass.
In: Modeling of Total Acid Precipitation Impacts. 1984. p 155-173, 14 Fig, 4 Tab, 22 Ref.

Descriptors: *Model studies, *Acidification, Acidic water, *Hydrologic models, *Lakes, *Mathematical models, Hydrogen ion concentration, Simulation analysis, Acids, Surface water, Snowmelt, Chemical properties, Weathering, Hydrologic budget, Filson Creek, Minnesota.

The trickle-down mathematical model was successfully calibrated with field data from Filson Creek watershed, Minnesota to predict whether present acid loadings are acidifying the lakes. Even though acidic loadings were moderate at Filson Creek (pH 4.8 of bulk precipitation and a sulfate load of 11 kg/ha/yr), a substantial pH depression was observed during snowmelt. Simulations showed that the average spring pH of Filson Creek would decrease from 6.2 to 5.0 if acidic deposition increased twofold. The greatest uncertainty in forecasting lake responses to increased acidic loadings was the kinetics of chemical weathering. Hydrologic flowrates and chemical weathering rates were the most sensitive parameters in their effect on surface water pH in the trickle-down model. The model can be used with annual acid depositional loadings for long term simulations.
W85-05320

DEVELOPMENT AND CALIBRATION OF THE INTEGRATED LAKE-WATERSHED ACIDIFICATION STUDY MODEL,
Tetra Tech, Inc., Lafayette, CA.
C. W. Chen, S. A. Gherini, J. D. Dean, R. J. M. Hudson, and R. A. Goldstein.
In: Modeling of Total Acid Precipitation Impacts. 1984. p 175-203, 15 Fig, 17 Ref.

Descriptors: *Model studies, *Watersheds, *Acidification, *Hydrologic models, *Lakes, *Chemical properties, *Hydrogen ion concentration, Forest watersheds, Calibrations, Limnology, Catchment areas, Sulfur, Nitrates, Soil chemistry, Simulation analysis, Air pollution.

As part of the Integrated Lake-Watershed Acidification Study (ILWAS), a deterministic model was developed to calculate surface and groundwater chemical characteristics, given watershed and time-varying inputs such as precipitation quantity and quality, and ambient air quality. Time-varying concentrations of 16 chemical constituents are simulated by a series of homogeneous compartments consisting of the forest canopy, snow, soil layers, streams and lakes. ILWAS model results compare well with hydrologic and chemical data collected from the Panther and Woods Lake-watershed systems in the Adirondack region of New York. The flowpaths and residence time of water in the soil (organic and inorganic strata) are important determinants of lake water chemistry. The decreased pH of Panther Lake surface water during the snowmelt period appears to be caused mainly by nitric acid. The basin alkalinity supply rate which is a function of input acidity and determines how a lake may respond to changes in acid load, is determined by basin characteristics and can be calculated by the ILWAS model.
W85-05321

METAL IONS IN BIOLOGICAL SYSTEMS, VOL. 18, CIRCULATION OF METALS IN THE ENVIRONMENT.
Marcel Dekker, Inc., New York, 1984. 350 p. Edited by H. Sigel and A. Sigel.

Descriptors: *Water chemistry, *Biological systems, Ecology, *Metals, Aquatic ecosystems, Environment, Aquatic environment.

This volume contains 10 chapters devoted to various aspects of the circulation of metals in the environment. Two chapters are of particular relevance to water resources applications. One discusses the regulation of trace metal concentrations in freshwater systems, and the second natural organic matter and metal-organic interaction in aquatic systems.
W85-05325

NATURAL ORGANIC MATTER AND METAL-ORGANIC INTERACTIONS IN AQUATIC SYSTEMS,
Geneva Univ. (Switzerland). Dept. of Inorganic, Analytical and Applied Chemistry.
J. Buffle.
In: Metal Ions in Biological Systems, Vol. 18, Circulation of Metals in the Environment. Marcel Dekker, Inc., New York, 1984. Edited by H. Sigel and A. Sigel. p 165-221, 8 Fig, 1 Tab, 181 Ref.

Descriptors: *Water chemistry, *Ecology, *Organic matter, *Metals, Aquatic life, Natural organic matter, Model studies, Metal complexes.

The development of aquatic and terrestrial life is linked to the transport processes which enable metals fixed on solid substrates to be brought to the surface of living organisms. The nature of metals which are the most likely to interact with organic matter may be estimated from considerations based on thermodynamics and stoichometry. Natural organic matter (NOM) in aquatic systems consists of a very complex mixture of compounds, including, in particular, many substances which can be classified within the major biochemical groups: carbohydrates, proteins and peptides, and lipids. Aquatic organic substances are always composed of a mixture, in various proportions, of pedogenic (soil derived) and aquogenic organic substances. Most experimental titration curves of NOM by metal ions suggest a continuous decrease in complexation strength rather than a few descrete transitions from strong to weak sites. A better understanding of the complexation properties of NOM demands the development of better techniques for separation and characterization, which would give more information on the nature of the minor complexing sites as well as the physical properties of NOM, particularly aggregation. The polydispersity of NOM's properties might be a fundamental characteristic of its ecological action and that any fractionation procedure, by reducing this polydispersity, may be considered as denaturing the properties of NOM leading to the observation of artificial properties.
W85-05326

REGULATION OF TRACE METAL CONCENTRATIONS IN FRESHWATER SYSTEMS,
Neuchatel Univ. (Switzerland).
P. Baccini.
In: Metal Ions in Biological Systems, Vol. 18, Circulation of Metals in the Environment. Marcel Dekker, Inc., New York. 1984. Edited by H. Sigel and A. Sigel. p 239-286, 28 Fig, 1 Tab, 56 Ref.

Descriptors: *Water chemistry, *Ecology, *Trace metals, *Rivers, Physicochemical treatment, Lakes, Biochemistry, Sinks, Ecosystems, Cooper, Zinc, Bioaccumulation.

The phenomenology of trace metal transport in freshwater systems and the field and laboratory studies on transfer mechanisms lead to several conclusions. In rivers, trace metal transport is primarily regulated by physicochemical processes. Surface chemical theory and the hydrodynamics of particle transport provide the necessary tools to predict the characteristics of trace metal transfers. Lakes serve as sinks for incoming trace metals in particulate form. Due to grain size fractioning the finer particles with higher trace metal concentrations are transported further into the basin. The ecosystem lake disposes of negative feedback mechanisms to control the concentration of essential trace metals such as copper and zinc to a certain extent. It is postulated that primary producers and the microbial decomposers aim to control the concentration of their dissolved and biologically available forms. The following biochemical mechanisms are applied to reduce the transfer of copper and zinc into the biota: decrease of biological uptake by reduction of proton activity in the substrate (trophogenic trace metal control) and decrease of trace metal concentration by formation of new adsorbing surfaces (tropholytic trace metal control).
W85-05327

CHARACTERIZATION OF GLENWOOD SPRINGS AND DOTSERO SPRINGS WATERS,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
R. J. Eisenhauer.
Available from the National Technical Information Service, Springfield, VA 22161. Report REC-ERC-83-10, October 1983. 52 p, 10 Fig, 14 Tab, 9 Ref, 2 Append.

Descriptors: *Spring water, *Salinity, Bicarbonates, Calcium, Trace metals, Anions, Sludges, Toxicity, Drinking water, Potable water, Groundwater quality.

Studies were initiated by the Colorado River Water Quality Office to quantify, characterize, identify beneficial uses, and find ways of preventing the waters from the Glenwood Springs and Dotsero Springs from entering the Colorado River. The Dotsero Springs are located in the Leadville limestone strata. Because of the high bicarbonate content of the Dotsero Springs Water, calcium could be reduced from 260 to 125 mg/l by partial lime treatment. Trace metals and trace anions were at a concentration of 0.1 mg/l or less and raw water met the toxicity limits for drinking water. Dehydrated salts or lime treatment sludges would not exceed toxicity limits for Resource Conservation and Recovery Act hazardous waste. The Glenwood Springs (GS) are located in the Leadville limestone strata. Because of the high bicarbonate content of GS water, calcium could be reduced from 470 to 238 mg/l by neutralization with lime (calcium hydroxide) to precipitate calcium carbonate. The trace metals and trace anions were less then 0.1 mg/l. The raw water exceeded or approached the limits of toxicity for drinking water for cadmium, chromium, fluoride, and selenium. However, chemical pretreatment and desalting necessary to bring water to below TDS limits would reduce cadmium, chromium, fluoride, and selenium below limits. The combined flow rate for the 25 identified surface springs (14 GS, plus 11 DS) of the GS-DS unit is 0.516 cu m/s (18.23 cu ft/s). The flow rate weighted average TDS for the unit is 15,016 mg/l. The salt load for the 11 DS was 69,050 metric tons annually and for the 14 GS was 174,700 metric tons annually.
W85-05329

SEASONAL AND ANNUAL VARIATION IN THE PRECIPITATION CHEMISTRY OF THE RHODE RIVER ECOSYSTEM,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
J. Miklas, T. L. Wu, and D. L. Correll.
In: Environmental Data Summary for the Rhode River Ecosystem (1970-1978), Section A: Long Term Physical/Chemical Data, Part 1: Airshed and Watershed, 1982. p 160-178, 4 Tab.

Descriptors: Data collections, *Maryland, *Chemistry of precipitation, Metals, *Hydrogen ion concentration, Organic matter, Nitrogen, Phosphorus, *Seasonal variation, Precipitation, Heavy metals, Cations, Nutrients, Calcium, Cadmium, Potassium, Baseline studies, Magnesium, Copper, Zinc, Iron, Rainfall, Nitrates.

The loading rates for total P, N, organic matter and metallic cations (K, Ca, Mg, Cu, Zn, Cd and Fe) were determined along with pH values in precipitation collected in rain gauges located at the Rhode River Estuary weather station. In general, the pH of rainwater declined from 1974 through 1976, but then stabilized from 1976 through 1978. Mean yearly loadings of P were 0.81 kg/ha (bulk) and 0.60 kg/ha (dryfall). Total N bulk loading averaged 10.5 kg/ha. Average yearly organic matter loading rates were 422,000 kcal/ha. On the average, 93% of this organic matter was dryfall. The majority of metals loading rates were highly variable, with no clear seasonal or yearly trends. Average yearly loading rates for the metallic nutrients Ca, K, and Mg were 10.89, 3.22 and 2.60 kg/ha, respectively. For heavy metals, average annual loading rates of Zn, Fe, Cu and Cd were 2090, 850, 62, and 26 g/ha, respectively.
W85-05355

RADIUM FLUXES FROM A SALT MARSH,
South Carolina Univ., Columbia. Dept. of Geology.
For primary bibliographic entry see Field 2L.
W85-05468

RECHARGE IN KARST AND DUNE ELEMENTS OF A SEMI-ARID LANDSCAPE AS INDICATED BY NATURAL ISOTOPES AND CHLORIDE,
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Soils.
For primary bibliographic entry see Field 2F.
W85-05530

HYDROGEOCHEMISTRY OF THE MEADE THRUST ALLOCHTHON, SOUTHEASTERN IDAHO, U.S.A., AND ITS RELEVANCE TO STRATIGRAPHIC AND STRUCTURAL GROUNDWATER FLOW CONTROL,
Colorado Univ. at Colorado Springs. Dept. of Geology and Applied Earth Sciences.
For primary bibliographic entry see Field 2F.
W85-05531

EFFECT OF WATER CHLORINATION ON THE TOXICITY OF COPPER TO PHYTOPLANKTON,
Maryland Univ., Solomons. Center for Environmental and Estuarine Studies.
For primary bibliographic entry see Field 5C.
W85-05581

PHOSPHORUS RELEASE FROM THE SEDIMENTS OF FLAMING GORGE RESERVOIR, WYOMING, U.S.A.,
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 2H.
W85-05630

VARIABILITY OF THE PHYSICO-CHEMICAL CHARACTERISTICS OF THE PONDS OF DOMBES (AIN) (LA VARIABILITE DES CARACTERISTIQUES PHYSICO-CHIMIQUES DES ETANGS DE LA DOMBES (AIN)),
Institut National de la Recherche Agronomique, Thonon-les-Bains (France). Station d'Hydrobiologie Lacustre.
G. Balvay.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1655-1660, December, 1984. 7 Fig, 9 Ref.

Descriptors: *Physico-chemical properties, *Ponds, *Dombes, *France, Minerals, Nutrients, Nitrates, Ammonia, Electrical conductivity, Hydrogen on concentration, Alkalinity, Fish farming, Aquaculture, Water quality, Upstream.

Dombes is the main fish farming region in France, producing about 1200 tons of fish per year. Water from 75 ponds in the Dombes was analyzed: conductivity varied from 51 to 344 micro-S/cm, the pH varied from 6.4 to 9.95, the alkalinity ranged from 0.19 to 2.72 meq/l, nitrates ranged from 0 to 0.61 mg N/l while ammonia nitrogen ranged from 0 to 2.6 mg N/l. The water chemistry varied continuously throughout the year. The variability which exists in the ponds studied may be the result of differences in the water sources. In many cases, the water passes along a chain of ponds, so that there is a progressive enrichment of minerals and nutrients. Each pond presents an individual case, but the relations with the ponds upstream must be considered in the improvement of the quality of water for aquaculture. (Moore-IVI)
W85-05650

GEOGRAPHICAL VARIABILITY IN THE NATURAL CHEMICAL COMPOSITION OF RUNNING WATERS (VARIABILITE GEOGRAPHIQUE DE LA COMPOSITION CHIMIQUE NATURELLE DES EAUX COURANTES),
Ecole Normale Superieure, Paris (France). Lab. de Geologie.
M. Meybeck.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1766-1774, December, 1984. 2 Fig, 2 Tab, 17 Ref.

Descriptors: *Chemical composition, *Chemical properties, *Geographical variability, Atmospheric deposition, Small watersheds, Silica, Potassium, Calcium, Magnesium, Carbonates, Sodium, Chloride, Sulfates, Lithology, Vegetation.

The water chemical composition (major elements) of unpolluted watersheds (10 sq km) is highly variable. Once the essential atmospheric inputs correction is realized, the spatial variability of elements reflects their other origins and pathways. It is minimum for SiO2 and K(+), limited for Ca(++), Mg(++), and HCO3(-) and maximum for Na(+), Cl(-) and SO4(--). This scattering is related to the influence of watershed lithology which produces various water-types in which any major ion may be dominant with the exception of potassium. On a continent scale, there is a general convergence to the calcium-carbonate type of waters. Other water quality factors, as climate, vegetation, altitude, relief and active volcanism are of secondary importance except on nutrients, which are much less variable and regulated by vegetation. Concentration statistics in the temperate region and in the world, and examples of major water-types, are given for major elements, nutrients, pH, conductivity and suspended matter. Referring to these natural variations, the 'world average reference water' concept is actually meaningless. (Author's abstract)
W85-05657

PHYSICAL AND CHEMICAL EVOLUTION OF SNOWPACKS ON THE CANADIAN SHIELD (WINTER 1979-1980),
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 2C.
W85-05659

ANALYSIS OF THE PROCESS OF RETENTION OF ORGANIC MATTER IN STREAM ECOSYSTEMS,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 2J.
W85-05664

UPTAKE OF DISSOLVED ORGANIC CARBON IN MOUNTAIN STREAMS,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W85-05665

SIZE DISTRIBUTION AND LIGNIN CONTENT OF FINE PARTICULATE ORGANIC MATTER (FPOM) FROM MICROBIALLY PROCESSED LEAVES IN AN ARTIFICIAL STREAM,
Alabama Univ. in Birmingham. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W85-05669

PHOSPHORUS UPTAKE BY DECOMPOSING LEAF DETRITUS: EFFECT OF MICROBIAL BIOMASS AND ACTIVITY,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2H.
W85-05670

INFLUENCE OF NITRATE ON THE PHOSPHORUS FLUX TO AND FROM OXYGEN DEPLETED LAKE SEDIMENTS,
Uppsala Univ. (Sweden). Limnologiska Institutionen.
T. Tiren, and K. Pettersson.
Hydrobiologia, Vol. 120, No. 3, p 207-223, January, 1985. 6 Fig, 3 Tab, 38 Ref.

Descriptors: *Nitrates, *Phosphorus, *Lake sediments, *Anaerobic conditions, Redox potential, Mineralization, Ammonium, Dissimilation, Sediments.

Addition of nitrate to an oxygen depleted sediment leads to a stimulation of the mineralization process if a major part of the nitrate is dissimilatorily reduced. This may cause an increased release of phosphate from some sediments. Nitrate, however, maintains a high redox potential at the sediment surface and thus prevents a release of iron-bound phosporus. These two counteracting effects of nitrate addition to sediment-water systems were demonstrated in laboratory experiments. A high supply of nitrate to a phosphorus-saturated sediment caused an increased release of phosphate and ammonium once the nitrate had been used up. However, from other sediments there was no or very little release of phosphate but an increased release of ammonium caused by high nitrate dissimilation, probably due to the very high capacity of these sediments to bind liberated phosphate or due to storage of phosphorus in an increased bacterial biomass. Phosphorus fractionation, before and after the experiments with the sediments, provided information on transfers to, from and within the sediments. (Author's abstract)
W85-05716

IN SITU METHANE PRODUCTION FROM ACID PEAT IN PLANT COMMUNITIES WITH DIFFERENT MOISTURE REGIMENS IN A SUBARCTIC MIRE,
Sveriges Lantbruksuniversitet, Uppsala. Institutionen foer Mikrobiologi.
B. H. Svennsson, and T. Rosswall.
Oikos, Vol. 43, No. 3, p 341-350, December, 1984. 4 Fig, 1 Tab, 34 Ref. Swedish Natural Science Research Council gontracts B 3358-002 and B 0313-037.

Descriptors: *Methane, *Peat, *Sweden, Plant communities, Nutrients, Wetlands, Subarctic zone, Carbon dioxide, Redox conditions.

The rate of release of methane to the atmosphere from an acid peat of a subarctic mire in northern Sweden was between 0.01 and 30 mg C/sq m/h in different plant communities, constituting a moisture and nutritional gradient from dry to wet and poor ombrotrophic to minerotrophic habitats. Methane production was positively correlated with moisture, and the higher nutrient content in the minerotrophic areas may also be of importance. The corresponding release of carbon dioxide (5.7-48.8 mg C/sq m/h) seemed unrelated to moisture and availability of nutrients. The methane could account for about 50% of the carbon flux to the atmosphere. The fluxes showed great variability in seemingly homogeneous areas, which might be explained by different redox conditions in the peat below. The highest methane production in the peat horizon was located between 10 and 15 cm below the surface, where Eh was at its lowest value. (Author's abstract)
W85-05720

NITROGEN FIXATION IN SUBARCTIC STREAMS INFLUENCED BY BEAVER (CASTOR CANADENSIS),
Woods Hole Oceanographic Institution, MA.
For primary bibliographic entry see Field 2H.
W85-05737

INFLUENCE OF THE SURFACE MICROLAYER ON NUTRIENTS, CHLOROPHYLL AND ALGAL DIVERSITY OF A SMALL EUTROPHIC BOG POND,
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
For primary bibliographic entry see Field 2H.
W85-05738

CARBON FLOW IN A SMALL TURBID MAN-MADE IMPOUNDMENT,
Orange Free State Univ., Bloemfontein (South Africa). Inst. of Environmental Sciences.
For primary bibliographic entry see Field 2H.
W85-05740

SEASONAL CHANGES IN THE CHEMISTRY AND BIOLOGY OF A MEROMICTIC LAKE (BIG SODA LAKE, NEVADA, U.S.A.),
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2H.
W85-05756

SEDIMENTOLOGY AND GEOCHEMISTRY OF SALINE LAKES OF THE GREAT PLAINS,
Manitoba Univ., Winnipeg. Dept. of Earth Sciences.
For primary bibliographic entry see Field 2H.
W85-05760

GEOCHEMISTRY OF GREAT SALT LAKE, UTAH I: HYDROCHEMISTRY SINCE 1850,
Calgary Univ. (Alberta). Dept. of Geology and Geophysics.
R. J. Spencer, H. P. Eugster, B. F. Jones, and S. L. Rettig.
Geochimica et Cosmochimica Acta, Vol. 49, No. 3, p 727-737, March, 1985. 10 Fig, 3 Tab, 41 Ref. NSF grant EAR-7903875.

Descriptors: *Chemical properties, *Saline lakes, *Great Salt Lake, *Utah, Hydrologic budget, Precipitation, Lake evaporation, History, Stratifica-

tion, Hot springs, Interstitial water, Lake sediments, Chemical precipitation.

The hydrochemistry of Great Salt Lake, Utah, has been defined for the historic period, 1850 through 1982, from published data combined with new observations. The water balance depends largely on river inflow, atmospheric precipitation onto the lake surface and evaporation. Input of the major solutes can best be accounted for by mixing dilute calcium-bicarbonate type river waters with NaCl-dominated hydrothermal springs. Prior to 1930, lake concentrations fluctuated inversely with lake volume in response to small climatic variations. Since then, salt precipitation and dissolution have significantly modified lake brine compositions and have led to density stratification and the formation of brine pockets of differing composition. Brine mixing has become an important component of brine evolution. Calculated evaporation curves are used with mineral precipitation and dissolution to clarify these processes. Pore fluids represent important storage for solutes. Solute profiles can be modeled by simple one-dimensional diffusion calculations. Short-term historic variations in lake composition affect shallow pore fluids in the upper 2 meters of sediment. (Author's abstract)
W85-05761

CONTINUUM MODEL FOR SIMULTANEOUS CHEMICAL REACTIONS AND MASS TRANSPORT IN HYDROTHERMAL SYSTEMS,
California Univ., Berkeley. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2F.
W85-05762

VARIATION IN PH DURING SUMMER STORMS NEAR THE CONTINENTAL DIVIDE IN CENTRAL COLORADO, U.S.A.,
Geological Survey, Lakewood, CO. Water Resources Div.
M. M. Reddy, T. D. Liebermann, J. C. Jelinski, and N. Caine.
Arctic and Alpine Research, Vol. 17, No. 1, p 79-88, February, 1985. 5 Fig, 7 Tab, 11 Ref. NSF grant BSR-8012095.

Descriptors: *Hydrogen ion concentration, *Rain, *Storms, *Continental Divide, *Colorado, Chemistry of precipitation, Acid rain, Specific conductance, Automation, Samplers, Rainfall intensity.

Precipitation acidity was monitored continuously from July to September 1983 at a well-instrumented research site located near the Continental Divide in Central Colorado. Rainfall amount, temperature, pH, and specific conductance were determined using a prototype device consisting of a modified wet-only precipitation collector with appropriate sensors. Data were recorded automatically with microprocessor control by preset time intervals. Weekly wet-only composite precipitation samples were also collected. Precipitation totaled 190 mm during the period, all as rain. Sixty-five percent of the continuous pH measurements were between 3.40 and 4.10, with an average of pH 3.80. Values of pH greater than 5.00 were rare. Composite samples were significantly less acidic, and averaged pH 4.36. Precipitation pH typically decreased rapidly as a storm began, was lowest near or slightly after the time of maximum rainfall intensity, then increased slightly. Paradoxical low pH and low specific conductance were recorded, and it is possible that some initial continuous pH measurements were too low. Acid loading varied widely among storms, and may have resulted largely from short bursts of high-intensity, low-pH rainfall. (Author's abstract)
W85-05766

2L. Estuaries

WATER QUALITY CHARACTERISTICS OF THE HARIMA NADA COASTAL AREA, COD LOAD CAUSED BY PRIMARY PRODUCTION,
Hyogo Prefecture Environmental Science Inst., Kobe (Japan).
H. Tanaka, T. Nakano, and H. Watanabe.
Water Research, Vol. 19, No. 2, p 133-141, 1985. 10 Fig, 17 Ref.

Descriptors: *Chemical characteristics, *Harima Nada, *Japan, *Coastal waters, *Chemical oxygen demand, *Primary productivity, Phytoplankton, Organic matter, Seasonal variation, Decomposing organic matter.

Accumulations of nutrients resulting from large quantities of fluvial discharge were observed in the coastal area of Harima Nada (Japan) during the rainy season period. The layer of water affected by the discharge reached depths of about 3-5 m from the surface. After the passing of the rainy season, increased sunlight and rising water temperature induced the abrupt development of phytoplankton in this layer of water. The organic pollution load caused by these increased populations was estimated to be 70-90% of the overall load of coastal surface water in summer time. After this period of abnormal growth ended, the polluted seawater gradually purified itself through biochemical degradation and precipitation. The time needed to transform organic matter into inorganic matter, however, was from 3 to 4 months. (Author's abstract)
W85-04969

NUMERICAL ESTUARINE FLOW MODEL,
Tulsa Univ., OK. Coll. of Engineering and Physical Sciences.
F. S. Henry, R. C. Ahlert, R. L. Peskin, and R. Vichnevetsky.
Water Resources Bulletin, Vol. 20, No. 6, p 823-831, December, 1984. 12 Fig, 21 Ref. Office of Water Research and Technology project A-044-NJ.

Descriptors: *Estuaries, *Numerical models, *Flow, *Streamflow, *Delaware Estuary, *Delaware River, *New Jersey, *Pennsylvania, *Delaware, Channel flow, Model studies, Path of pollutants.

Tidal elevations and volume flow rates predicted by a novel flow model compare well with available field data for the Upper Delaware Estuary (New Jersey, Pennsylvania, Delaware). The model provides some two-dimensional features while using an essentially one-dimensional approach which results in a numerically stable and reasonably mass conservative model. Because data were not available, the velocities predicted to occur in the UDE could not be verified, but the model was shown to be able to match velocities given by an analytical solution to a simple channel flow. The model describes some two-dimensional features of estuarine flow that cannot be generated with conventional one-dimensional models. The model predicts that there is significant advective lateral motion in the UDE. It is assumed that these lateral motions are caused largely by the fact that the estuary's cross-stream bottom profile changes with downstream distance; the dispersion resulting from the lateral motions could significantly enhance the speed at which cross-sectional mixing occurs. Using the model velocity output, maps of particle paths were constructed to describe the advective motions predicted to occur in the UDE; the particles were assumed to be neutrally bouyant and non-diffusive. The maps indicate the influence of the Schuylkill River on the net lateral advective motion in the Camden-Philadelphia area; in this region the net lateral movement is always from the Pennsylvania bank towards the New Jersey bank. (Collier-IVI)
W85-04987

VERTICAL DISTRIBUTION OF AL, CU, FE AND ZN IN THE SOIL SALT MARSHES OF THE SADO ESTUARY, PORTUGAL,
Universidade Nova de Lisboa (Portugal). Dept. of Chemistry and Biotechnics.
For primary bibliographic entry see Field 5B.
W85-05032

CRITIQUE OF PRESENT WETLANDS MITIGATION POLICIES IN THE UNITED STATES BASED ON AN ANALYSIS OF PAST RESTORATION PROJECTS IN SAN FRANCISCO BAY,
Stanford Univ., CA. Program in Human Biology.
M. S. Race.
Environmental Management, Vol. 9, No. 1, p 71-81, January, 1985. 4 Tab, 27 Ref.

Descriptors: *Wetlands, *San Francisco Bay, *California, *Restoration, *Man-made marshes, Estuarine environment, Habitats, Ecosystems.

A detailed evaluation of past wetland restoration projects in San Francisco Bay was undertaken to determine their present status and degree of success. Many of the projects never reached the level of success purported and others have been plagued by serious problems. On the basis of these findings, it is debatable whether any sites in San Francisco Bay can be described as completed, active, or successful restoration projects at present. In spite of these limited accomplishments, wetland creation and restoration have been adopted in the coastal permit process as mitigation to offset environmental damage or loss of habitat. However, because the technology is still largely experimental, there is no guarantee that man-made wetlands will persist as permanent substitutes for sacrificed natural habitats. Existing permit policies should be reanalyzed to insure that they actually succeed in safeguarding diminishing wetlands resources rather than bartering them away for questionable habitat substitutes. Coastal managers must be more specific about project requirements and goals before approval is granted. Continued research on a regional basis is needed to advance marsh establishment techniques into a proven technology. In the meantime, policies encouraging or allowing quid pro quo exchanges of natural wetlands with man-made replacements should proceed with caution. The technology and management policies used at present are many steps ahead of the needed supporting documentation. (Author's abstract)
W85-05070

'HET GOORKEN' AND 'DE LOKKERSE DAMMEN' (ARENDONK, BELGIUM): I. INTRODUCTION AND PHYTOSOCIOLOGICAL SURVEY (HET GOORKEN EN DE LOKKERSE DAMMEN (ARENDONK, BELGIE); 1. INLEIDING EN FYTOSOCIOLOGISCHE SCHETS),
Antwerp Univ., Wilrijk (Belgium). Dept. of Biology.
D. De Baere, and R. Mahieu.
Bulletin de la Societe Royale de Botanique de Belgique, Vol. 117, No. 2, p 328-340, 1984. 1 Fig, 6 Tab, 14 Ref.

Descriptors: *Peat bogs, *Vegetation, *Het Goorken, *Lokkerse Dammen, *Belgium, *Arendonk, Species composition, Bogs, Wetlands, Aquatic plants, Heaths.

The state nature reserve 'het Goorken' and the private nature reserve 'de Lokkerse Dammen' formed until the middle of the last century the source region of the river Wamp. Some important hydrological interventions decreased the oligotrophic character and the surface of open water in the studied peat-bog. The phytosociological description of the vegetation was carried out, using the Braun-Blanquet method. A great diversity of vegetation types has been distinguished, varying from water plant vegetation, over oligotrophilous and etrophilous peat-bog communities up to carr. At some places a heath-vegetation was observed. (Author's abstract)
W85-05072

VERIFICATION OF A MODEL OF THE EASTERN SCHELDT,
RAND Corp., Santa Monica, CA.
J. J. Leendertse.
Report R-3108-NETH. April 1984. Rand Corp., Santa Monica, CA. 127 p, 96 Fig, 6 Tab, 7 Append. Contract/Grant No. DED-2091.

Descriptors: *Simulation Analysis, *Mathematical Model, *Flow Rates, *Estuaries, Salinity, Hydraulic Models, Tidal Effects, Transport Rates, Eastern Scheldt, Netherlands.

A verification simulation of a model of the Eastern Scheldt is described. Boundary conditions for a simulation of flows and water levels on 11 January 1982 were obtained from gauging stations in the offshore area of the estuary using weighting functions obtained from simulations with other models of conditions of September 1975 in the offshore area. The simulation was made first without taking into account the effects of the varying density in the estuary. By operating the model in this mode a direct comparison with a hydraulic model could be made. Good agreement was obtained between observed and computed transport rates through the Hammen, Schaar, and Roompot. The agreement is better than that obtained with a comparable simulation with the hydraulic model. To investigate the effect of the representation of a narrow channel, called the Eendracht, with the two-dimensional representation of the model, two experiments were made with a part of the model extending eastward from the Zeeland bridge. These experiments indicated that: 1) the accuracy of the model in the vicinity of the channel ends can be improved by coupling the two-dimensional model with a one-dimensional representation of this channel; and 2) tide gauge data at existing stations can be used directly as boundary conditions for this part of the model. Simulation results indicated a very good agreement between observed and computed transport rates through the Hammen, Schaar, and Roompot. The simulation in which the pressures resulting from salinity were included in a better agreement with the observed data than the simulation without the salinity. The quarter-diurnal tidal component was the most difficult to reproduce in the model.
W85-05121

FINAL REPORT ON EFFECT OF FENTHION ON SELECTED ESTUARINE SPECIES RELATED TO FIELD STUDY,
Environmental Research Lab., Gulf Breeze, FL.
For primary bibliographic entry see Field 5C.
W85-05124

EFFECT OF THREE MARSH MANAGEMENT TECHNIQUES ON THE ECOLOGY OF IRREGULARLY FLOODED CHESAPEAKE BAY WETLANDS: VEGETATION AND WATER QUALITY STUDIES, PARTS I AND II,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
For primary bibliographic entry see Field 4A.
W85-05347

ENVIRONMENTAL DATA SUMMARY FOR THE RHODE RIVER ECOSYSTEM (1970-1978), SECTION A: LONG TERM PHYSICAL/CHEMICAL DATA, PART 1: AIRSHED AND WATERSHED,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
1982, 600 p. Edited by David L. Correll.

Descriptors: *Baseline studies, *Rhode River Estuary, *Maryland, *Estuaries, *Ecosystems, *Watersheds, *Hydrologic data collections, *Meteorological data collections, Soil profiles, Rhode River Program, Chesapeake Bay, Water quality, Chemistry of precipitation, Land use, Data collections, Geological surveys, Estuarine environment, Suspended solids, Cations, Nutrients.

This report summarizes most of the long-term, intensive physical and chemical data which were collected from 1970 to 1978 on the Rhode River, Maryland. The Rhode River program seeks to establish an understanding of the operation of this ecosystem with special emphasis upon the interaction of the watershed and the estuary and to monitor long-term changes in the ecosystem and relate them to the activities of man as well as to other variations in environmental conditions. The main purposes of this report are to make summary data for monthly, seasonal, and yearly means and variances readily available for interdisciplinary use by investigators at this site, to make the data more available to other sites for comparison purposes, and to serve as a necessary step in the synthesis and analysis of rather complex data sets. The report includes detailed studies on meteorological parameters, precipitation chemistry, geology and solids, soil profiles for three single-land-use Rhode River Watersheds, hydrology, discharge of solids, cations and nutrients, and certain stream water quality parameters.
W85-05353

DISCHARGE OF SOLIDS FROM RHODE RIVER SUBWATERSHEDS,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
For primary bibliographic entry see Field 5B.
W85-05360

SEASONAL AND ANNUAL VARIATION IN NUTRIENT DISCHARGE FROM RHODE RIVER WATERSHEDS AND CERTAIN STREAM WATER QUALITY PARAMETERS,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
For primary bibliographic entry see Field 5B.
W85-05361

SEASONAL AND ANNUAL VARIATION IN THE DISCHARGE OF METALLIC CATIONS FROM RHODE RIVER WATERSHEDS,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
For primary bibliographic entry see Field 5B.
W85-05362

RADIUM FLUXES FROM A SALT MARSH,
South Carolina Univ., Columbia. Dept. of Geology.
M. S. Bollinger, and W. S. Moore.
Nature, Vol. 309, No. 5967, p 444-446, May, 1984. 2 Fig, 13 Ref.

Descriptors: *Salt marshes, *Radium, *Isotope studies, Water analysis, Coastal waters, Cycling nutrients, Metals, Marshes, Interstitial water, Tidal effects, Tidal creeks, Bly Creek, South Carolina.

Bly Creek, a small marsh-tidal creek system near Georgetown, South Carolina, was chosen to determine the flux of Ra-228 and its great granddaughter, Ra-224 form the sediments to the ridal creek water. The highest activities of Ra-224 and Ra 228 in the tidal creek waters occur during low tide, but Ra-226 activity remains relatively constant throughout the tidal cycle. There is a large input of radium from the march sediments to the overlying waters. To produce the necessary fluxes, irrigation and bioturbation must replace interstitial water in the top 5 cm of the marsh sediments every 2-3 days. The short residence time of water in the top centimeters of the salt marsh sediments and the high flux of radium out of the sediments demonstrate that marshes are extremely active chemical systems able to respond to changing conditions on a time scale of days. These observations have important implications for the understanding of the cycling of nutrients, metals, carbon and pollutants in coastal systems. (Baker-IVI)
W85-05468

MATHEMATICAL MODELLING OF TIDAL CURRENTS IN THE HUMBER ESTUARY,
Birmingham Univ. (England). Dept. of Civil Engineering.
R. A. Falconer, and P. H. Owens.
Journal of the Institution of Water Engineers and Scientists, Vol. 38, No. 6, p 528-542, December, 1984. 10 Fig, 13 Ref.

Descriptors: *Model studies, *Mathematical models, *Tidal currents, *Estuaries, *Humber Estuary, *England, Tidal waters, Waves, Flooding, Hydrodynamics, Bathymetry, Velocity.

A mathematical model is described which has been used to predict water elevations and the two dimensional tide induced velocity fields in the Humber Estuary. The model makes use of the finite difference method to solve the depth integrated hydrodynamic equations governing tidal motion in the estuary. The drying out and flooding of shallow tidal waters in the estuary is included in the model using a new technique, which is particularly suited to models having a relatively large grid size. A non-conventional method of including the bathymetry has also been used, which gives rise to a more accurate evaluation of the depth mean velocity. The model has been calibrated and compared with field measured results taken by the British Transport Docks Board and an encouraging agreement between both sets of results has been obtained. The choice of the bed resistance coefficient was quite critical, particularly towards the head of the estuary. From the example results shown of the depth mean horizontal velocity field predictions, the new drying and flooding technique appeared to simulate the physical process satisfactorily, with the flow past Spurn Head giving rise to separation and strong tidal eddies in the lee of the peninsular. This hydrodynamic phenomenon forms an important aspect of the tidal circulation in the Humber Estuary. (Baker-IVI)
W85-05516

ECOSYSTEM DEFINITION AND COMMUNITY STRUCTURE OF THE MACROBENTHOS OF THE NEMP MONITORING STATION AT PIGEON HILL IN THE GULF OF MAINE,
New Hampshire Univ., Durham. Dept. of Zoology.
A. W. Hulbert, K. J. Pecci, J. D. Witman, L. G. Harris, and J. R. Sears.
Available from the National Technical Information Service, Springfield, VA 22161, as PB83-112474, NOAA Technical Memorandum NMFS-F/NEC-12. May 1982. 143 p. 16 Fig, 10 Tab, 9 Append, 63 Ref.

Descriptors: *Aquatic ecosystems, *Baseline studies, *Benthic fauna, *Benthic flora, Algae, Computers, Photography, Sampling, Bioaccumulation, Heavy metals, Polychlorinated biphenyls, Hydrocarbons, Bioindicators.

The Pigeon Hill station forms part of the baseline ecosystem definition of the National Oceanic and Atmospheric Administration's Northeast Monitoring Program (NEMP). The purpose of this report is to provide a quantitative baseline description of the dominant faunal and floral components of the Pigeon Hill benthic communities. The station was marked and permanent transects were established utilizing a stratified sampling procedure with horizontal and vertical substrata and 33 and 42 m depths. Disruptive sampling techniques were used to establish descriptive community baselines; quantitative photography was subsequently used for following the stability of the communities. A total of 149 species were identified from the disruptive samples. Horizontal communities are dominated by an algal-polychaete matrix offering a large amount of secondary substrate. Vertical surfaces are dominated by sponges, tunicates and brachiopods. Body burdens of heavy metals, PCB's and anthropogenic hydrocarbons have been established for algae, asteroids, and tunicates. Pigeon Hill, at present, is a healthy, relatively pristine location in the midst of a commercial fishery and heavy shipping traffic. The benthic communities at Pigeon Hill primarily are composed of boreal species of the exposed coast. Community dominants have been identified as indicator species and are being tracked using predominantly quantitative photographic techniques in very site-specific subhabitats.
W85-05580

STUDIES ON THE BOTTOM SEDIMENTS OF AL-HAMMARA MARSH AREA IN SOUTHERN IRAQ,
University Coll., Cardiff (Wales). Dept. of Plant Science.
S. E. Antoine.
Limnologica (Berlin), Vol. 16, No. 1, p 25-28, September, 1984. 1 Tab. 15 Ref.

Descriptors: *Marshes, *Al-Hammara Marsh, *Iraq, *Bottom sediments, Sediments, Organic matter, Calcium, Magnesium, Sodium, Potassium, Plankton, Decomposition, Macrophytes, Wastewater pollution.

The sediments of Al-Hammara marsh were collected and analyzed for the first time. The organic matter content was high, mainly due to the death and disintegration of sedimented plankton and the decay of dead benthic animals and plants. Allochthonous organic input with sewage from a small village at site III also increased the load, resulting in the largest quantity of organic material at that site. The calcareous substances were remarkably abundant due to the presence of large amounts of calcareous shells and shell fragements in the sediments. Macrophytic growth may also contribute calcareous substances as they are usually covered with calcified felts of blue-green algae. The allochthonous material and diatom silica content were lower than that of calcareous substances. Diatom silica constitutes the major part of the HCl-insoluble fraction of the sediment (allochthonous material plus diatom silica). The nutrient content of the sediments was found in adequate quantities. Slow currents or almost stagnant water in the area give the sediments a better chance to absorb more nutrients. The nutrient content varied directly with that of the organic matter. The highest nutrient content at site III, was partly due to sewage disposal. Lower nitrate values were found than for phosphate because nitrate ions are readily lost to the deeper sediment layers, and the phosphate ones are firmly absorbed on the sediment particles. Phosphates were positively correlated with the calcium. The silica contents are mainly affected by the amounts of diatom frustules found in the sediments. High calcium contents were correlated with the high calcareous substances of the sediments. Calcium and magnesium contents were also correlated with the high organic matter contents. Disintegration of dead benthic green plants and settled dead phytoplankton may replenish some of the magnesium of the sediments. Sodium and potassium were found adequately, particularly the latter, mainly due to the fact that significant amounts of these ions are still available from the deeper sediment layers to the superficial ones since the past transgressions of the sea have left a residue of the marine salt in the sediments of the lower plain of Iraq. Surface runoff and seepage may also add some of these ions to the sediment load. (Baker-IVI)
W85-05613

HYDROBIOLOGY OF STRELASUND (ZUR HYDROBIOLOGIE DES STRELASUND),
Ernst-Moritz-Arndt Univ., Greifswald (German D.R.).
H.-J. Subklew.
Limnologica (Berlin), Vol. 16, No. 1, p 191-205, September, 1984. 9 Fig, 2 Tab, 35 Ref.

Descriptors: *Aquatic life, *Strelasund, *Germany (Democratic Republic), Coastal waters, Sounds, Vegetation, Beaches, Wind, Physicochemical properties, Zooplankton, Aquatic animals, Fish, Water pollution, Wastewater pollution.

Strelasund is a sound between the mainland at Stralsund and the Isle of Rugen, German Democratic Republic. The aim of the present study is to summarize all hydrobiological and hydrographical values concerning this body of water. Information is given on the following: the soil, shores and vegetation; wind, water level, and the floodplain; physico-chemical properties of the water; biomass of zooplankton; shore plants; fauna (metazoans); fish; and wastewater and pollution. In the last 30 years this landscape has changed to an important industrial region and recreation center. (Moore-IVI)
W85-05616

NOTE ON TURBULENT PERTURBATIONS OF SALINITY IN A PARTIALLY MIXED ESTUARY,
Birmingham Univ. (England). Dept. of Civil Engineering.
J. R. West, and K. Shiono.
Estuarine, Coastal and Shelf Science, Vol. 20, No. 1, p 55-78, January, 1985. 16 Fig, 5 Tab, 28 Ref.

Descriptors: *Salinity, *Estuaries, *Mixing, Turbulence, Salinometers, Internal waves, Error analysis.

Salinity perturbations measured in a partially mixed estuary were used to evaluate the usefulness of an inductive salinometer and to determine some of the characteristics of the salinity peturbations. The salinometer performed satisfactorily under most conditions. Although internal wave like effects were present, the turbulence fluctuations were dominant. The salinity and salt flux records based on the inductive salinometer measurements had adequate stationarity, systematic and random error characteristics. The high frequency cut-off of two of the salinity records and the random errors of the vertical salt flux were the least satisfactory results of the error analysis. The salinity and salt flux time series had skewness and flatness values which are similar to those for homogeneous flow turbulence parameters in laboratory flumes. A quadrant analysis showed that the normalized flux in each quadrant was sensitive to the gradient Richardson number. (Moore-IVI)
W85-05689

MACRO-INVERTEBRATE POPULATIONS AND PRODUCTION ON A SALT-MARSH IN EAST ENGLAND DOMINATED BY SPARTINA ANGLICA,
Essex Univ., Colchester (England). Dept. of Biology.
D. Jackson, C. F. Mason, and S. P. Long.
Oecologia, Vol. 65, No. 3, p 406-411, February, 1985. 2 Fig, 6 Tab, 33 Ref.

Descriptors: *Salt marshes, *Invertebrates, *Productivity, *Spartina, *England, Biomass, Canopy, Wetlands, Marshes, Standing crop.

The populations and production of the macroinvertebrates of a Spartina anglica salt-marsh in eastern England were studied over two years. A total of fifteen species were recorded in the sediments, of which twelve species were of regular occurrence, and the total population density recorded ranged from 3,481 sq m to 11,444 sq m over the twenty-four sampling occasions. The four most abundant species were Nereis diversicolor, Tubifex costatus, Corophium volutator and Hydrobia ulvae. Thirteen further taxa were associated with the canopy of Spartina, with a total population density ranging from 0 to 1,149 sq m. Total monthly standing crop ranged from 1.8 to 8.5 g C/sq m with peaks in July/August in both years. Nereis diversicolor contributed 55% to 86% of total biomass in each month. Production and respiration for each species was determined and annual assimilation calculated. The total annual production was about 16 g C/sq m/a in both 1979 and 1980, with a corresponding assimilation of about 60 g C/sq m/a. Nereis diversicolor accounted for > 80% of production and assimilation in both years, and the species is clearly of considerable potential importance in the dissipation of Spartina material. The canopy dwelling species accounted for about 1% of the total annual production and assimilation. (Author's abstract)
W85-05703

RELATIONSHIP OF PHYSICAL FACTORS AND BIOLOGICAL RESPONSE IN COASTAL SEAGRASS MEADOWS,
Florida State Univ., Tallahassee. Dept. of Biological Science.
R. J. Livingston.
Estuaries, Vol. 7, No. 4A, p 377-390, December, 1984. 7 Fig, 4 Tab, 47 Ref.

Descriptors: *Seagrasses, *Gulf of Mexico, *Coastal areas, Floods, Temperature, Salinity, Water quality, Algae, Habitats, Productivity, Predation, Competition, Food chain, Estuarine environment.

Continuous, long-term studies of coastal grassbed assemblages in the N.E. Gulf of Mexico indicate complex relationships between physical controlling factors and biological response. Such seagrass systems are physically unstable over short periods. Seasonal ranges of temperature, salinity, and natural water quality conditions are considerable with periodic, recurrent 'catastrophic' events such as floods and cold winters. These factors control the distribution and productivity of the seagrasses and algae which constitute the habitat and organic substrate for diverse assemblages of organisms. In addition, the benthic plants mediate predator-prey relationships and competitive interactions. Despite the physical instability, timed sequences of distinct ontogenetic feeding populations are generally stable from year to year as are other population and community characteristics. Thus, physical processes determine overall habitat conditions and productivity cycles whereas biological processes such as predation and competition define specific community relationships. Seemingly minor changes in the physical environment due to anthropogenous activities can lead to major reorganization of the biological system; the observed biological stability of the seagrass beds can be ephemeral if important habitat features are altered in a way that exceeds the adaptive response of the system. Concepts are discussed which relate observed sequences of ontogenetic feeding units to food web patterns and geographic differences of population-niche relationships from one estuary to another. (Author's abstract)
W85-05705

DEPENDENCE OF FISHERY SPECIES ON SALT MARSHES: THE ROLE OF FOOD AND REFUGE,
Louisiana Universities Marine Consortium, Chauvin.
D. F. Boesch, and R. E. Turner.
Estuaries, Vol. 7, No. 4, p 460-468, December, 1984. 1 Fig, 48 Ref.

Descriptors: *Salt marshes, *Fisheries, *Food, *Refuge, Fish, Crustaceans, Detritus, Marshes, Algae, Macrophytes, Tidal creeks, Habitats.

Salt marshes are widely believed to serve as nurseries for many fishes and crustaceans of fishery value as a result of the high production of vascular plant detritus and the protection from predation offered by shallow, spatially complex habitats. Comparisons of the yields of species which reside in salt marsh habitats during critical life history stages (such as penaeid shrimp) with the area of such habitats and their greater densities in flooded marshes and associated tidal creeks support the premise that marshes enhance the yield of such species. A range of evidence, including the amount of detrital export from marshes, the poor nutritive value of vascular plant detritus, and natural diets, casts doubt on the notion that production of fishery species is based on the direct consumption of marsh grass detritus or predominantly on food chains based on this detritus. Vascular plants and associated algae may, however, contribute to the production of prey species. The limited observations available support the hypothesis that salt marshes offer significant escape from mortality due to predation, but there have been yet few experimental tests of this hypothesis. Knowledge of relative importance of the food and refuge functions in support of living resources is of practical value in marsh and fisheries management. Better understanding of these roles is important to the effective evaluation of the effects of coastal habitat modifications on fisheries resources and design of alterations to minimize the losses of these values. (Author's abstract)
W85-05706

EFFECT OF SEDIMENTATION ON THE PRIMARY PRODUCTION OF BENTHIC MICROFLORA,
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
G. P. Shaffer.
Estuaries, Vol. 7, No. 4B, p 497-500, December, 1984. 2 Fig, 1 Tab, 15 Ref. NOAA grants 04-7-158-44121 and NA80AA-D-00120.

Descriptors: *Benthic flora, *Primary productivity, *Sedimentation, *Mugu Lagoon, *California, Environmental effects, Runoff, Storm runoff, Benthic fauna, Sediments.

In February, 1978, during a study of the primary production of the benthic microflora inhabiting the intertidal and subtidal flats in the eastern arm of Mugu Lagoon, California, a major rainstorm oc-

curred. As a result of the runoff associated with the heavy precipitation, up to 50 cm of fresh silts and clays were deposited in the deepest parts of the lagoon. For February-July 1978, this deposition decreased the net primary production of the benthic community by an estimated 6.5 fold (from 135 +/- 11.7 g C/ sq m to 21 +/- 2.0 g C/sq m). Persistence of fine-grained sediment over much of the lagoon may continue to render these areas lower in exportable organic carbon. Unless another source of primary production provides the balance of the organic carbon, reductions in the epibenthic macrofauna should occur as well. (Moore-IVI)
W85-05707

DISTRIBUTION AND ABUNDANCE OF SUBMERGED AQUATIC VEGETATION IN CHESAPEAKE BAY: AN HISTORICAL PERSPECTIVE,
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5C.
W85-05709

HYDROGRAPHY, NUTRIENTS, SUSPENDED ORGANIC MATTER, AND PRIMARY PRODUCTION IN A SHALLOW FJORD SYSTEM ON THE WEST COAST OF NORWAY,
Oslo Univ. (Norway). Biologisk Inst.
P. Wassmann, and A. Aadnesen.
Sarsia, Vol. 69, No. 3-4, p 139-153, 1984. 13 Fig, 1 Tab, 68 Ref.

Descriptors: *Fjords, *Hydrography, *Nutrients, *Organic matter, *Primary productivity, *Norway, Suspended solids, Nitrates, Silicon dioxide, Phosphates, Biomass, Wind, Phytoplankton, Coastal areas.

The investigation was carried out at three stations in a coastal area, characteristic for the west Norwegian coast; 21 cruises cover the period February to October 1982. The hydrography (T C, S%, O2/H2S), the nutrient concentration (NO3(-), SiO2, PO4(3-)), suspended organic biomass (chlorophyll a, phaeophytin, particulate organic carbon, and nitrogen), and in situ C-14-assimilation were measured at fixed depths. The predominant northerly and southerly winds and the resulting on-shore and off-shore transport of water had a significant influence on the hydrography at the outer station in Raunefjorden, somewhat less at the intermediate station in Kviturdvikpollen, but were of minor influence at the permanently stratified inner station in Vagsbopollen. Hydrogen sulfide occurred in the bottom water of both Vagsbopollen and Kviturdvikpollen from June to October. Maximum concentrations were up to 6 times higher than reported in a study 18 years ago in the same localities. The concentrations of nutrients and suspended organic matter were highest in Vagsbopollen and Kviturdvikpollen. Highest suspended concentrations were found at the oxic/anoxic interface. In Raunefjorden the nutrient and suspended organic matter concentrations were strongly influenced by upwelling of nutrient-rich water. The annual primary production at the three stations ranged from 180 to 230 g C/sq m per year. The topography of the fjords, the fresh-water run-off, and changes in the predominantly longshore wind stress are essential for an understanding of the phytoplankton dynamics in the area. (Author's abstract)
W85-05713

ESTUARINE MEAN FLOW ESTIMATION REVISITED: APPLICATION TO THE ST. LAWRENCE ESTUARY,
Institut National de la Recherche Scientifique, Rimouski (Quebec). Centre d'Oceanologia.
V. G. Koutitonsky, and M. I. El-Sabh.
Journal of Marine Research, Vol. 43, No. 1, p 1-12, February, 1985. 3 Fig, 1 Tab, 17 Ref.

Descriptors: *Estuaries, *Flow, *St. Lawrence Estuary, Water circulation, Water currents, Statistical analysis, Estimation.

Mean value estimate errors for estuarine (and oceanic) parameters which exhibit serial correlation and nonstationarity over a finite record length are discussed. It is shown that when trends are nonlinear over the record length, the mean value estimate error does not decrease with time. Instead, it goes through a minimum and then increases again. An optimal averaging time over which the mean estimate error is minimum is presented. The mean circulation in the lower St. Lawrence estuary is described over a record length of 78.5 days in 1979. Standard, bias, and rms errors in mean value estimates are discussed, and an averaging time yielding a minimum error is suggested for the lower St. Lawrence estuary. New measured features of the mean circulation are: a coastal current flowing downstream near the shore which deflects to the right at the mouth, and a 2 cm/s inflow in the bottom layer at mid-channel location. (Author's abstract)
W85-05736

PHYSICO-CHEMICAL CHARACTERISTICS AND PHYTOPLANKTON OF THE ENCANIZADA, TANCADA AND BUDA COASTAL LAGOONS (EBRO RIVER DELTA) (CARACTERISTICAS FISICAS Y QUIMICAS Y FITOPLANCTON DE LAS LAGUNAS COSTERAS, ENCANIZADA, TANCADA Y BUDA (DELTA DEL EBRO)),
Barcelona Univ. (Spain). Dept. de Ecologia.
F. A. Comin.
Oecologia Aquatica, Vol. 7, p 79-162, July, 1984. 46 Fig, 9 Tab, 83 Ref.

Descriptors: *Lagoons, *Encanizada, *Tancada, *Phytoplankton, *Buda, *Ebro River Delta, *Spain, Coastal waters, Physicochemical properties, Deltas, Conductivity, Nutrients, Diatoms, Biomass, Salinity, Eutrophication, Nutrients.

Three coastal lagoons - Encanizada, Tancada and Buda - of the Ebro River Delta were studied to determine physicochemical characteristics to relate the phytoplankton population to environmental factors. The three lagoons are very shallow with a mean water level of about 50 cm. The relative abundance of the main cations in the three lagoons followed the same pattern as in the sea: Na> Mg> Ca> K. In Encanizada nutrient levels were higher in late spring, decreasing gradually towards late summer, with a shift in the N/P ratio. A typical seasonal succession of diatoms, chlorophyceans and blue-green algae as in eutrophicated freshwater lakes characterizes the phytoplankton in the Encanizada lagoon from May to December. The ratio of primary production/biomass was higher in Tancada than in Encanizada. In general this ratio was higher in both lagoons during winter and spring, the period of rapid increase of salt concentration, than during the rest of the year. Salinity changes control phytoplankton development and chemical characteristics of the three coastal lagoons studied. Encanizada was also strongly affected by the higher nutrient concentrations of freshwater inflows from May to December. It maintains its hypertrophic status during the rest of the year while major changes take place in the phytoplankton community while it adapts to the increasing salinity. A smaller watershed and less concentration in flows maintain the Tancada lagoon at a lower trophic status. Slight differences can be observed between the two basins of this lagoon. In Buda, the inflows from the river mouth produce continuous changes in the salt concentration which varies within a narrower range during the year. It does not develop a rich phytoplankton community as in Encanizada and Tancada. (Baker-IVI)
W85-05749

AQUATIC MACROPHYTE FLORA OF SALINE WETLANDS IN WESTERN AUSTRALIA IN RELATION TO SALINITY AND PERMANENCE,
Murdoch Univ. (Western Australia). School of Environmental and Life Science.
M. A. Brock, and J. A. K. Lane.
Hydrobiologia, Vol. 105, p 63-76, November, 1983. 5 Fig, 5 Tab, 22 Ref.

Descriptors: *Macrophytes, *Wetlands, *Saline lakes, *Western Australia, Salinity, Ephemeral lakes, Intermittent lakes, Aquatic plants, Seasonal variation, Submerged plants.

Fluctuations of salinity, depth and permanence (presence of water) are common in saline lakes in Western Australia and may occur on a seasonal or longer time scale. Monitoring of salinity and depth of over 80 wetlands reserved for the conservation of flora and fauna begin in 1978 in Western Australia. Over 100 reserves have gauges which are monitored at two monthly intervals. Cataloging of the macrophytes in these reserves began in 1980 and has continued through 1982. Submerged macrophytes were recorded in 66% of the lakes examined. Species of the two monocotyledon genera Ruppia and Lepilaena and the charophyte Lamprothamnium show wide tolerance of both salinity fluctuation and habitat drying. These plants occur in both permanent and ephemeral wetlands with salinities which show extremely large seasonal salinity fluctuations from slightly saline to hypersaline. Macrophytes were not recorded in 30 of the 84 wetland sampled; most of these were fresh ephemeral or hypersaline ephemeral lakes. Of the wetlands sampled, 235 were permanent and contained 31% of the macrophyte records. The other 69% of the plant records were in ephemeral lakes (77% of lakes): 52% were in seasonal ephemeral lakes and 17% in intermittent ephemeral lakes. A large proportion of plant occurrences are from the salinity categories with the highest ranges of fluctuation (40% of wetlands). The plasticity of morphology and life cycle (e.g. variable dormancy) in members of all three genera probably account for their survival in these environmental extremes. (Moore-IVI)
W85-05752

LOWER MISSISSIPPI SALINITY ANALYSIS,
Tippetts-Abbett-McCarthy-Stratton, New York.
A. Balloffet, and D. K. Borah.
Journal of Hydraulic Engineering, Vol. 111, No. 2, p 300-315, February, 1985. 11 Fig, 1 Tab, 15 Ref, 1 Append.

Descriptors: *Mississippi River, *Saline water intrusion, *Saline wedge, *Simulation analysis, Model studies, River flow, Saline-freshwater interfaces.

Two procedures were developed to simulate salinity intrusion in the Mississippi River. The first one is based on the arrested salinity wedge theory and is applicable to quasi-steady-state flow conditions. It simulated very well the experimental results of Keulegan (1966, 'The Mechanism of an Arrested Saline Wedge,' Chapter 11, 'Estuarine and Coastline Hydrodynamics,' Ippen, ed., McGraw-Hill Co., New York, NY, p 546). It also simulated the positions of salt wedge tips and their interfaces in the Mississippi River with proper adjustment of the interfacial friction factor. The second one is a steady-dynamic routing model, which routes salt water in a cascade of reservoirs in the river bottom. Densimetric critical flow is assumed over a reservoir ridge. Error in storage definition is included in a calibration coefficient for the salt-water flow computations over the reservoir ridges. The model satisfactorily simulated durations of salt wedge presence along the lower Mississippi for the existing conditions and after deepening the channel to 55 ft. (Author's abstract)
W85-05785

MATHEMATICAL MODELS OF DISPERSION IN RIVERS AND ESTUARIES,
Liverpool Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
For primary bibliographic entry see Field 2E.
W85-05832

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

TRANSPORT STUDIES OF MULTIELECTROLYTE SOLUTIONS ACROSS A SINTERED

Group 3A—Saline Water Conversion

DISC IMPREGNATED WITH CELLULOSE ACETATE,
Himachal Pradesh Univ., Shimla (India). Dept. of Chemistry.
R. L. Blokhra, M. L. Parmar, and S. S. Thakur.
Journal of Membrane Science, Vol. 21, No. 2, p 123-135, November, 1984. 6 Fig, 2 Tab, 28 Ref.

Descriptors: *Desalination, *Membrane processes, *Electro-osmosis, *Cellulose acetate, Ammonium chloride, Ammonium nitrate, Chlorides, Nitrates, Streaming potential, Electrokinetic energy, Thermodynamics.

This study attempted to evaluate phenomenological coefficients from electroosmosis and streaming potential data in the case of multielectrolyte systems; to test the validity of the linear phenomenological relationships; to verify Onsager's symmetry relationships; and to evaluate the efficiencies of electrokinetic energy conversion. The data for different aqueous solution of ammonium chloride-ammonium nitrate through a sintered disc impregnated with cellulose acetate at 30 C were analyzed in the light of non-equilibrium thermodynamics. The Onsager reciprocity relation was found to hold good for all the systems. The efficiencies of electrokinetic energy conversion have also been determined. The maximum values of conversion efficiencies for both the modes of conversion, electroosmotic flow and streaming potential, were found to be equal to each other and independent of the applied input forces. This study may prove relevant to the use of cellulose acetate in the water desalination process and the possibility of using electroosmotic methods for desalination. (Baker-IVI)
W85-05035

SIGNIFICANCE OF EFFECTS IN A REVERSE OSMOSIS DESALINATION UNIT,
Cairo Univ. (Egypt). Faculty of Engineering.
S. G. Serag-El-Din.
Desalination, Vol. 51, No. 3, p 231-254, September, 1984. 7 Fig, 8 Tab, 4 Ref.

Descriptors: *Desalination, *Reverse osmosis, *Membrane processes, Brackish water, Water treatment, Temperature effects, Flow rate, Membranes.

A reverse osmosis laboratory module using a cellulose acetate membrane and synthetic brackish water was studied using a factorial-2 design of experiments. The effects of varying the feed pressure, the feed temperature, and the feed flowrate on both the water flux and salt rejection percentage were investigated. All the effects studied (feed pressure, feed temperature, and feed flowrate) were significant at a 5% probability level. The most significant effect, as regards either the water flux or the salt rejection percentage, is the feed pressure. This is followed in significance by the feed temperature. Of all the linear effects, the feed flowrate is the least significant. Whereas no interactions are evidently significant in the case of salt rejection percentage, two significant interactions appear in the case of water flux. The effect of all the factors on the water flux is positive. Whereas the effects of feed pressure and feed flowrate are positive on the salt rejection percentage, that of feed temperature is negative. None of the operating conditions used yield a water which complies with the freshwater specifications for a once-through operation. A once-through operation followed by a single recycle, both held at the best operating conditions (feed pressure - 61.2 atm, feed temperature = 45 C, and feed flowrate = 8 l/min), using the RO unit and the cellulose acetate membrane of this work, yields freshwater of 438 ppm TDS. The water flux in this case will be half of the magnitude of the flux obtained by a once-through operation. An alternative practical technique would be to use 2 RO units in series, with the first unit producing a 111.95 l/sq m/hr flux of 1600 ppm, this being fed to the consecutive unit which produces a 115.65 l/sq m/h flux of 438 ppm. (Baker-IVI)
W85-05113

SOLUBILITIES AND SUPERSATURATIONS OF CALCIUM SULFATE AND ITS HYDRATES IN SEAWATER,
Technische Hogeschool, Delft (Netherlands). Dept. of Chemical Engineering and Chemistry.
J. A. M. Meijer, and G. M. Van Rosmalen.
Desalination, Vol. 51, No.2 , p 255-305, September, 1984. 6 Fig, 4 Tab, 66 Ref.

Descriptors: *Solubility, *Supersaturation, *Seawater, *Calcium sulfate, Hydrates, Gypsum, Calcium sulfate, Mathematical equations, Desalination.

In seawater desalination technology the prevention of calcium sulfate deposition is one of the more critical conditions for continuous operation of a desalination plant. To determine the driving force for calcium sulfate depositions from a supersaturated saline water solution of known composition, three quantities must be calculated; the solubility product, the ratio of the mean activity coefficients of calcium sulfate and the ratio of the activities of water. The transition temperature for gypsum into hemihydrate is 98 C in pure water. At this temperature the gypsum solubility line ends, since the dissociation pressure of gypsum exceeds the vapor pressure of the solution above this temperature. The transition temperature for gypsum into anhydrite is 40 C in pure water. This transition temperature can only be determined by solubility measurements. The application of vapor pressure experiments to establish this transition temperature is not permitted since the direct dissociation of gypsum into anhydrite does not exist. When other salts are present, both transition temperatures shift to lower temperature values, depending on the concentration of the added salts. A simple equation is given for calculating the growth affinity for seawater solutions at concentration factors betwen 1.0 and 7.0. (Baker-IVI)
W85-05114

CELLULOSE TRIACETATE MEMBRANES FOR SEAWATER DESALINATION,
Central Salt and Marine Chemicals Research Inst., Bhavnagar (India).
S. V. Joshi, and A. V. Rao.
Desalination, Vol. 51, No. 3, p 307-312, September, 1984. 4 Fig, 1 Tab, 5 Ref.

Descriptors: *Membrane processes, *Desalination, *Seawater, *Cellulose triacetate, Water treatment, Membranes, Reverse osmosis.

Experimental data on reverse osmosis using a sodium chloride solution by cellulose triacetate (CTA) membranes are presented. The investigation involved studies on the composition of membrane casting solution and their effects on the performance. Several casting formulations were studied in detail and the necessary proportions of each component are worked out from the observations. Different additive materials such as magnesium perchlorate, phthalic anhydride, maleic anhydride, dimethylphthalate, acetic acid, maleic acid and maleic anhydride plus methanol were stubstituted for the maleic anhydride in the original casting solutions. Membranes were tested on 35,000 ppm sodium chloride solution at 1000 psi operating pressure. Though all substances tried are additive for CTA, it is not yet completely clear which substance controls the membrane uniformity and clarity of the casting solution. Proper control over these two parameters is primarily important for evaluating high salt rejection membranes. (Baker-IVI)
W85-05115

CROSSFLOW MEMBRANE TECHNOLOGY AND ITS APPLICATIONS,
Osmonics, Inc., Hopkins, MN.
For primary bibliographic entry see Field 5D.
W85-05506

DEVELOPMENT OF AN AUTOMATED PLUGGING FACTOR MONITOR,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
R. J. Eisenhauer, and C. G. Goodner.
REC-ERC-81-12, December 1981. 13 p, 8 Fig, 2 Append, 2 Ref.

Descriptors: *Membrane processes, *Reverse osmosis, *Automation, *Electronic equipment, *Cellulose acetate membranes, *Membrane filters, *Desalination apparatus, *Hydraulic equipment, Desalination, Membranes, Filtration, Monitoring, Plugging factor, Filter rate, Process control.

Efficient and economical control of a reverse osmosis membrane water desalting process is dependent on the rapid, repetitive, and correct monitoring of the feedwater parameter known as the plugging factor. The plugging factor test is a measurement of the percent decrease in flow rate through a 0.45 micron cellulose-acetate Millipore filter membrane with a constant pressure differential of 207 KPa (gage) after 15 minutes. Several test devices are available to plant operators for monitoring the feedwater plugging factor, but their operation requires close manual attention and their results often vary in accuracy. A totally automic plugging factor monitor (PFM) was developed and tested at the Yuma Desalting Test Facility in Yuma, Arizona. The PFM tester allows selection and monitoring of water samples every 20 minutes. Resulting plugging factor calculation accuracies are within 0.4%.
W85-05597

3B. Water Yield Improvement

SYSTEMS FOR RAINFALL AND RUNOFF USE, TUCSON, ARIZONA,
Arizona Univ., Tucson. Office of Arid Lands Studies.
K. J. DeCook, and K. E. Foster.
Water Resources Bulletin, Vol. 20, No. 6, p 883-888, December, 1984. 2 Fig, 1 Tab, 11 Ref.

Descriptors: *Rainfall, *Runoff, *Tucson, *Arizona, *Water resources development, *Water supply development, Domestic water, Groundwater recharge, Urban watersheds.

There are many opportunities for using rainfall and runoff in the Tucson urban and suburban area. With diminishing supplies of groundwater which is Tucson's primary municipal water source, the use of harvested rainfall and runoff are attractive and technically feasible alternatives. Residential rainfall-harvesting systems include a catchment surface (the primary impact and catchment area is the rooftop), collection and concentration components, separation and treatment units, storage capacity and distribution capability. While the amount of precipitation in the Tucson urban area is sufficient to supply only a portion of residential household needs, it can provide a significant quantity of water to augment or partially substitute for the piped-in supply. For example, a 1700 square foot rooftop will yield about 10,625 gallons annually assuming an average annual rainfall of 11 inches and a collection efficiency of 90%; this will supply only about 11% of the current municipal input for residential water consumption. A system to control runoff can divert water form urban washes for use in parks or other landscaped areas or can be used to enhance recharge to groundwater reservoirs. A reduction in flood hazards or peaks is a concurrent benefit of controlling and diverting runoff. (Collier-IVI)
W85-04995

EFFECT OF SLOPE AND RAINFALL INTENSITY ON EROSION FROM SODIUM DISPERSED, COMPACTED EARTH MICRO-CATCHMENTS,
Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.
S. R. Evett, and G. R. Dutt.
Soil Science Society of American Journal, Vol. 49, No. 1, p 202-206, January-February, 1985. 2 Fig, 3 Tab, 28 Ref. USDA grant 82-CRSR-2-2005.

Descriptors: *Rainfall intensity, *Soil erosion, *Slopes, *Water harvesting, Microcatchments, Compacted earth, Sodium soil dispersion, Slope stability, Interrill erosion, Erosion control.

Erosion studies were conducted on microcatchments for the purpose of designing water harvest-

ing systems. Two replicates of a two factor experimental plot design, including 1, 5, 10, and 15% slopes and 3 and 6 m lengths, were built on a gravelly sandy clay loam using 11.2 Mg/ha of NaCl mixed into the surface 2 to 5 cm of soil followed by compaction with a 6-Mg roller after a heavy rain. Most of the erosion was from interrill erosion. The effects of slope and maximum 30 min rainfall intensity were significant at the 0.1% level for the 11 storms studied. The sodium treated surface layer is estimated to last up to 20 yr under these conditions if slopes are kept to 5% or lower on these microcatchments of less than 6 m length. The same soil loss could occur within 12 yr on areas with a 15% slope with most of the sodium dispersed surface layer being gone in that length of time. (Baker-IVI)
W85-05191

CONTINUING DESIGN, REVIEW, AND ANALYSIS WORK FOR THE SIERRA COOPERATIVE PILOT PROJECT,
North American Weather Consultants, Salt Lake City, UT.
R. D. Elliott, D. A. Griffith, J. A. Flueck, and J. F. Hannaford.
Available from the National Technical Information Service, Springfield, VA, 22161. Interim Report No. 6, Report SLWN-83-2, September 1983. 135 p, 53 Fig, 18 Tab, 21 Ref. Contract/Grant No. 7-07-83-V0008.

Descriptors: *Cloud seeding, *Sierra Cooperative Pilot Project, *Computer models, Statistical analysis, *Weather modification, *Artificial nucleation, Clouds, Convective precipitation, Sierra Hydrotech, Simulation analysis, Statistical models, *Project Skywater.

This work describes the research activities of Flueck Associates and Sierra Hydrotech, between September 1982 and August 1983, concerning the continuing design, review, and analysis work on the Sierra Cooperative Pilot Project (SCPP) being sponsored by the Bureau of Reclamation in the Northern Sierra Nevada of California. Work was conducted in the review and revision of an earlier SCPP-1 design developed as an exploratory research program on post-frontal convection. Statistical simulations and assessments were conducted to examine the detectability of seeding signatures. The computer model GUIDE, was used to simulate the effects of seeding transposed on natural SCPP-1 clouds. Using similar methods, work was also conducted on the preliminary design of an exploratory research program on the SCPP concerning the stratiform cloud forms.
W85-05349

EXPERIENCES IN THE USE OF EAST ANGLIAN SANDS AND GRAVELS ('CRAGS') AS A SOURCE OF WATER SUPPLY,
East Anglian Water Co., Cambridge (England).
For primary bibliographic entry see Field 5F.
W85-05517

3C. Use Of Water Of Impaired Quality

MUNICIPAL WASTEWATER INCREASES CROP YIELDS,
Arizona Water Resources Research Center, Tucson.
A. D. Day, and C. B. Cluff.
BioCycle, Vol. 26, No. 1, p 48-49, January/February, 1985. 2 Tab, 12 Ref.

Descriptors: *Crop yield, *Municipal wastewater, *Arizona, *Wastewater irrigation, Wastewater disposal, Sorghum, Plant growth, Minerals, Nitrogen, Phosphorus, Salts.

The use of municipal wastewater as a source of irriation water and plant nutrients in the commercial production of sorghum and grain and forage was investigated. The influence of municipal wastewater on sorghum grain volume-weight was also studied. The pump water contained approximately 3,654, 16.2, 16.2, and 0.0 ppm of total soluble salts, nitrate nitrogen, total nitrogen, and phosphorus, respectively. The wastewater-pump water mixture contained about 1,910, 8.1, 30.1, and 3.7 ppm of total soluble salts, nitrate nitrogen, total nitrogen, and elemental phosphorus, respectively. About 91 cm of irrigation water were used to produce the sorghum crops. Average water penetrations were similar for the two types of irrigation water. Total soluble salts and nitrate nitrogen were higher in the pump water than in the wastewater-pump water mixture. The latter contained higher levels of total nitrogen and phosphorus than did pump water alone. The lower concentrations of salts in the wastewater pump water mixture indicate that this irrigation water was of a higher quality than pump water and, therefore, more desirable for growing plants. In 1975 and 1976, plants irrigated with the wastewater-pump water mixture grew taller, produced more heads per unit area, and produced higher grain yields than plants grown with pump water alone. Sorghum grain volume-weight was the same for both irrigation treatments in both years. Sorghum irrigated with the wastewater pump water mixture produced higher forage yields than did sorghum grown with pump water alone in both years. Taller plants and higher yields of both grain and forage were obtained when the wastewater pump water mixture was used for irrigating sorghum, indicating that municipal wastewater can be used effectively as a partial source of irrigation water and plant nutrients in the commercial production of sorghum in Arizona and also in similar environments throughout the world. (Baker-IVI)
W85-05059

WATER USE, GROWTH AND RUBBER YIELDS OF FOUR GUAYULE SELECTIONS AS RELATED TO IRRIGATION REGIMES,
Texas A and M Univ., El Paso. Agricultural Research and Extension Center.
For primary bibliographic entry see Field 3F.
W85-05166

PRELIMINARY STUDY OF SOLAR PONDS FOR SALINITY CONTROL IN THE COLORADO RIVER BASIN,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
W. J. Boegli, M. M. Dahl, and H. E. Remmers.
Available from the National Technical Information Service, Springfield, VA 22161. Bureau of Reclamation Report REC-ERC-82-19. December 1982. 60 p, 25 Fig, 17 Tab, 46 Ref, 5 Append.

Descriptors: *Salinity, *Saline water, *Solar energy, *Solar distillation, *Desalination, *Electric power production, *Thermal energy, linings, Mine wastes, Coal mines, Nonconsumptive use, Colorado River Basin, Cost analysis, Danby Dry Lake, Sevier Dry Lake, California, Utah.

The technical and economic benefits were investigated of using solar salt-gradient ponds in the Colorado River Basin to provide salinity control and to produce project power and freshwater. It was assumed that the saline water needed for pond construction would be transported to one of two dry lakebeds in the Basin (Danby Dry Lake in southern California or Sevier Dry Lake in western Utah) as part of a salinity control/coal transport project. The ponds would be used to generate electric power that could be integrated with the Bureau's power grid or used in combination with thermal energy from the ponds to power commercially available desalination systems to produce freshwater. Economic benefits were compiled for two methods of concentrating the necessary brine for the ponds - one representing stage construction using collected brine only and the other using salt at the site to produce the concentrated brine. Results of the economic analysis show solar ponds offer benefit-cost ratios of 2.1 and 2.9 and annual cost savings of 41 and 61%, respectively, for baseload and intermediate load operations when compared to similar facilities powered by fossil fuels.
W85-05306

ADVANCED WATER RECYCLING SYSTEM REQUIRED FOR NEW SOUTH AFRICAN MILL,
Main (Charles T.), Inc., Boston, MA.
B. M. Jonsson.
Pulp and Paper, Vol. 58, No. 12, p 62-66, December, 1984. 6 Fig.

Descriptors: *Water reuse, *Recycling, *Pulp and paper industry, Water resources development, Water supply development.

Environmental and economic conditions have made process water reuse a necessity in the operation of a pulp and paper mill. The amount of water that can be reused is dependent on, and varies with, local conditions. The complex water recycling system of a major new integrated pulp and paper mill in Ngodwana, South Africa is examined. The mill is engineered for a combined production of 1,600 tpd of bleached pulp, linerboard grades, and newsprint. Water intake is limited to 6.605 million gal/day, and the process effluent is limited to 3.831 million gal/day. Four basic recirculation loops are used in the system. Loop 1 takes filtrate from the whitewater silo for use in dilution from stock preparation consistency to headbox consistency. In loop 2 cloudy filtrate from the saveall is used for slushing the wet lap pulp to the necessary stock preparation consistency. In loop 3 filtrate reclaimed from the vacuum system separators and press section trays is reused after filtering in the groundwood mill and secondary fiber system. In loop 4 clear saveall filtrate is deaerated, clarified, and filtered prior to reuse as former and press section shower water. Freshwater is continuously used for oscillating, high pressure wire cleaning showers, trim jets, all roll internal uses, and the felt cleaning showers. (Baker-IVI)
W85-05777

3D. Conservation In Domestic and Municipal Use

HOW MUCH WATER CAN YOU SAVE WITH CONSERVATION MEASURES,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
Y. M. Walski, W. G. Richards, D. J. McCall, A. K. Deb, and J. M. Morgan.
Public Works, Vol. 115, No. 9, p 96-97, September, 1984. 2 Tab, 4 Ref.

Descriptors: *Water conservation, *Prediction, Estimating, Planning, Conservation, Water use.

A procedure has been developed for preparing quick estimates of the effectiveness of water conservation measures. The term effectiveness is used to express the change in water use and is usually given in units of flow, while the term reduction is used to describe the fractional change in effectiveness. The procedure used to estimate water conservation effectiveness for a given community consists of four basic parts: produce a flow estimate of the separate uses; look up the appropriate reduction factor from the table for each combination of measure and sector being considered; multiply the values; and sum the products to obtain the total estimated effectiveness. Two examples are provided to illustrate the use of the method to estimate the amount of water use reduction in Westchester County, New York, and in New Jersey, Hamilton Township. (Baker-IVI)
W85-05483

3E. Conservation In Industry

HOW MUCH WATER CAN YOU SAVE WITH CONSERVATION MEASURES,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 3D.
W85-05483

3F. Conservation In Agriculture

IRRIGATION FOR CROPS IN A SUB-HUMID ENVIRONMENT, VII. EVALUATION OF IRRIGATION STRATEGIES FOR COTTON,
Commonwealth Scientific and Industrial Research Organization, Narrabri (Australia). Cotton Research Unit.
A. B. Hearn, and G. A. Constable.
Irrigation Science, Vol. 5, No. 2, p 75-94, April, 1984. 8 Fig, 5 Tab, 11 Ref.

Descriptors: *Irrigation practices, *Cotton, *Water stress, *New South Wales, Waterlogging, Subhumid climates, Climates, Water potential, Leaves, Crop yield, Nitrogen.

Empirical functions to predict the nitrogen uptake, increase in leaf area index and minimum leaf water potential (LWP) of cotton were incorporated into a water balance model for the Namoi Valley, New South Wales. A function was then developed to describe the lint yield of irrigated cotton as a function of water stress days at 4 stages of development, total nitrogen uptake and days of waterlogging. Nitrogen uptake was reduced by 0.98 kg per ha and yield reduced by 33.2 kg lint/ha for each day of waterlogging. The optimum practice was found not to irrigate until 60 days from sowing and until the deficit in the root zone reached 50%. When the supply of water was less than 7 Ml/ha there was no advantage in either delaying the start of irrigation or irrigating at a greater deficit; it was economically more rational to reduce the area sown or, if already sown, to irrigate part with 6 Ml/ha and leave the rest as a raingrown crop. The simulation showed that there is no single set of practices that is always best in every season; in a number of seasons, practices other than those which on average are best, give better results. (Baker-IVI)
W85-05165

WATER USE, GROWTH AND RUBBER YIELDS OF FOUR GUAYULE SELECTIONS AS RELATED TO IRRIGATION REGIMES,
Texas A and M Univ., El Paso. Agricultural Research and Extension Center.
S. Miyamoto, J. Davis, and K. Piela.
Irrigation Science, Vol. 5, No. 2, p 95-103, April, 1984. 5 Fig, 3 Tab, 13 Ref.

Descriptors: *Water demand, *Crop yield, *Irrigation, *Guayule, Plant growth, Irrigation practices, Saline water, Water stress.

The effects of irrigation regimes on water use, shrub growth, and rubber and resin yields of four guayule selections were investigated. An optional objective was to evaluate the effect of saline water irrigation on water use, growth and rubber yields. It appeared that large quantities of water are required to produce sufficient amounts of guayule biomass. The amount of irrigation water used to produce 1 t of dry shrub per ha, ignoring the contribution of rainfall, ranged from 13 to 16 cm, varying little with irrigation regimes. Rubber content was highest under the wet regime, mainly because of its large biomass but also because rubber contents remained relatively high. Environmental factors as well as the genetic potential of guayule would likely dictate rubber yields under low water stess and the value of heavy irrigation on guayule. (Baker-IVI)
W85-05166

STUDIES ON THE NITROGEN AND WATER RELATIONS OF WHEAT, II. EFFECTS OF VARYING NITROGEN AND WATER SUPPLY ON GROWTH AND GRAIN YIELD,
Waite Agricultural Research Inst., Glen Osmond (Australia).
For primary bibliographic entry see Field 2I.
W85-05167

WATER RELATIONS OF DROUGHT-RESISTANT AND DROUGHT-SENSITIVE WHEAT CULTIVARS SPRINKLED WITH SALINE WATER,
Kansas Agricultural Experiment Station, Manhattan. Evapotranspiration Lab.
M. B. Kirkham.
Irrigation Science, Vol. 5, No. 2, p 137-146, April, 1984. 5 Fig, 1 Tab, 18 Ref.

Descriptors: *Saline water, *Wheat, *Crop yield, *Plant growth, *Drought resistance, Water stress, Water demand, Leaves, Turgor, Stomatal resistance, Osmotic potential, Water potential.

Water potential, osmotic potential, turgor potential, and stomatal resistance were measured on leaves of a drought-sensitive and a drought-resistant cultivar of winter wheat treated with foliar applications of NaCl to determine the effect of salt on the water status of two cultivars varying in drought resistance. With water and salt both cultivars survived; with drought and salt, both cultivars died. With salt and drought, however, the drought-sensitive cultivar had a lower turgor potential, a higher apparent resistance, and died sooner, than did the drought-resistant cultivar. These results indicate that the drought-resistant cultivar might be better able to survive under dry and saline conditions than the drought-sensitive cultivar, because, with the low stresses, the resistant cultivar could maintain a higher turgor potential and a greater flow of water through the plant than the sensitive cultivar. The stomatal resistance increased when salt was sprayed on leaves. Stomatal closure may be a general response for leaves of all plants treated with salt. To determine the importance of stomata in controlling entry of salts into the leaves it will be necessary to identify a cultivar that keeps its stomata open when sprayed with salty water. (Baker-IVI)
W85-05168

EFFECT OF SOIL MOISTURE REGIMES ON THE YIELD AND WATER USE OF LENTIL (LENS CULINARIS MEDIC),
Indian Agricultural Research Inst., New Delhi. Water Technology Center.
For primary bibliographic entry see Field 2I.
W85-05171

CONSUMPTIVE USE OF WATER BY MAJOR CROPS IN THE SOUTHWESTERN UNITED STATES,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 2I.
W85-05346

CONDITIONAL DISTRIBUTIONS OF NEYMAN-SCOTT MODELS FOR STORM ARRIVALS AND THEIR USE IN IRRIGATION SCHEDULING,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W85-05795

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

PRELIMINARY RESULTS OF CALCULATING THE DELIVERY OF WATER FROM THE ONEGA BAY RESERVOIR TO THE BASIN OF THE CASPIAN SEA IN A COMPENSATING REGIME,
A. S. Berezner.
Water Resources, Vol. 11, No. 2, p 125-129, March-April, 1984. 1 Fig, 2 Tab, 7 Ref. Translated from Vodnye Resursy, No. 2, p 69-73, March-April, 1984.

Descriptors: *Onega Bay, *USSR, *Reservoirs, *Caspian Sea, *Water transfer, Water supply development, Water management, Planning.

Transfer of water from the Onega Bay of the White Sea is being examined as a final measure in the overall program of water transfer into the Caspian basin. The increase in irrigated area is expected to cease in the first quarter of the next century, stabilizing nonreturnable water consumption in the Caspian basin; this makes a further increase in transfers unnecessary. To evaluate the effect of compensating feeding it is necessary to perform water management calculations with the use of a sufficiently long series. Such observations were performed on the basis of a 60 year series, from 1914/15 to 1973/74, for which there are data of observations both on northern rivers and on the Volga and Caspian Sea. The surface area of the Onega Bay is about 10,000 sq km, the useful storage at a height of the drawdown level of 4-5 m is equal respectively to 40-50 cu km. The optimal capacity of the water-lifting cascade was then determined. The volume of transfer with probability p = 75% is determined to be 34.1 cu km/yr, and the average value of transfer during years when the Caspian level drops below -28.50 m is 37.8 cu km/yr. The results as presented must be regarded as a first approximation. (Baker-IVI)
W85-05155

CHARACTERIZATION OF GLENWOOD SPRINGS AND DOTSERO SPRINGS WATERS,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
For primary bibliographic entry see Field 2K.
W85-05329

EFFECT OF THREE MARSH MANAGEMENT TECHNIQUES ON THE ECOLOGY OF IRREGULARLY FLOODED CHESAPEAKE BAY WETLANDS: VEGETATION AND WATER QUALITY STUDIES, PARTS I AND II,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
D. Whigham, J. O'Neill, and M. McWethy.
Coastal Zone Unit, Maryland Dept. of Natural Resources, Annapolis, MD. 1982. Part I: 248 p, 16 Fig, 25 Tab, 5 Append, 63 Ref; Part II: 47 p, 11 Fig, 12 Tab, 10 Ref.

Descriptors: *Nutrients, *Ecological effects, *Water quality, *Marsh management, *Marsh plants, *Tidal marshes, *Primary productivity, *Drainage ditches, Environmental effects, Tidal effects, Marshes, Vegetation effects, Coastal marshes, Salt marshes, Biomass, Mosquitoes, Wetlands.

A two year study was conducted to determine the effects of ditching on the ecology of irregularly flooded Chesapeake Bay wetlands. Three sites on the Deal Island Wildlife Management Area were ditched in 1979. One area (Open Site) received standard Open Water Marsh Management treatment and was coupled to the adjacent estuary to permit complete tidal exchange. Water control structures were used at a second site (Water Control Site) to permit partial tidal coupling. The third ditched area (Closed Site) was not coupled to the estuary. Two unditched areas served as control sites. Changes in vegetation composition were still ongoing at all sites after two years. Distichlis spicata (Salt grass) and Spartina patens (Saltmeadow cordgrass) were co-dominant species of the wetlands prior to ditching. After one year D. spicata was the dominant species at the Open and Water Control Sites. By the second year Iva frutescens (Marsh elder) and Baccharis halimifolia (Seamyrtle) were abundant at the Open Site and by 1981 were also abundant at the Water Control Site. S. patens became the dominant species at the Closed Site where there has been no invasion by I. frutescens or B. halimifolia. Nitrogen and phosphorus concentrations have been higher in plant tissue and decomposition rates of litter have decreased at the three treated sites. Changes in vegetation composition, nutrient concentrations and decomposition rates are attributed to lowering of the water tables at the three treated sites. No major changes in water quality parameters occurred at any of the sites, and intra-site differences in water quality parameters were greater than inter-site differences. Results of tidal cycle studies conducted at the

Open Site, compared to the Control Site, that there would be a continuous export of nutrients whenever ditched areas are completely coupled to the estuary. (Author's abstract)
W85-05347

COLORADO SNOW: A RESOURCE AND A RESPONSIBILITY,
Fort Collins, CO.
A. G. Krempel.
Public Works, Vol. 115, No. 8, p 58-60, August, 1984. 4 Fig.

Descriptors: *Snow, *Colorado, *Snow removal, Blizzards, Water resources development, Snowmelt, Avalanches, Irrigation water.

As a resource, snow is critical for irrigation, skiing and water for recreational fishing. As a responsibility, the heavy snows must be cleared for highways, roads, and mountain passes. The area is heavily dependent on the water from snowmelt in the mountains for irrigation on the western plains. To make beneficial use of snowmelt in Colorado, there was a great effort at the turn of the century to develop trans-mountain diversion ditches to bring the water from the western slope of the Rockies, which gets more snow, to the eastern slope. The state has an annual $20 million snow removal budget. There are eight highway districts each divided into three to five patrols. Whiteouts on low roads, avalanches on high roads, and hazardous conditions in both areas sometimes require employees to take their lives in their hands. In an attempt to control avalanches, some are intentionally triggered by shells from a howitzer, or a new gun designed just for this purpose. A brief summary of the past four blizzards to hit this area is provided. (Baker-IVI)
W85-05480

STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA,
WRC Engineering, Inc., Denver, CO.
W. P. Ruzzo, and M. Serlet.
Public Works, Vol. 115, No. 9, p 116-119, September, 1984. 2 Fig, 2 Tab, 1 Ref.

Descriptors: *Storm drainage, *Drainage control, *Urban runoff, Runoff, Storm runoff, Urban areas, Design criteria.

In order to provide a more specific, up to date, and easier to use manual than currently available, a complete drainage manual was prepared for Boulder County and Longmont, Colorado. The goals of the manual were to unify standards and improve the quality of drainage evaluation and design by providing specific and detailed criteria for the local communities; to reduce the effort required to prepare and review drainage designs by simplifying the methodologies and procedures and by providing numerous worked examples; to provide the necessary information to prepare and review a drainage design within a single document that is complete, organized, and easily referenced; and to provide a drainage evaluation and design criteria that will prevent future drainage problems and enhance the urban environment within the goals and objectives of the community. Even though the manual was prepared specifically for Boulder County and Longmont, the general content and organization can be used for any urbanized area. (Baker-IVI)
W85-05484

TEMPERATURE AND LIGHT EFFECTS ON THE GROWTH OF POTAMOGETON CRISPUS IN COLLINS LAKE, NEW YORK STATE,
Union Coll., Schenectady, NY. Dept. of Biology.
P. Tobiessen, and P. D. Snow.
Canadian Journal of Botany, Vol. 62, No. 12, p 2822-2826, December, 1984. 2 Fig, 1 Tab, 16 Ref.

Descriptors: *Temperature effects, *Light intensity, *Curly leaved pondweed, *Aquatic weed control, *Collins Lake, *New York, Plant growth, Dredging, Biomass, Ice cover, Pondweed.

Collins Lake in east central New York State is a shallow, 24 ha, calcarous lake which was dominated by Potametgeton crispus. In the spring, about 60% of the area of the lake was covered by a virtually pure stand of this species. During the summers of 1977 and 1978, part of the lake was dredged to a depth of 3.3 m, which reduced the biomass and density of P. crispus nearly a thousand-fold in the dredged portion of the lake. P. crispus is a cold water plant adapted to habitats with low light intensities. Plants survive under ice at light intensities of 2 microE/sq m/sec and will grow in the lab at 7 microE/sq m/sec at 10 C and above, or less than 1% of the surface irradiance in the spring. After germination in the fall, its lack of response at cold temperatures prevents biomass accumulation and shoot elongation under the ice, even in the shallower portions of the lake where light intensities might otherwise permit them. Stem proliferation was reduced in low light intensities under typical lake temperatures, so that the dredged areas contained very low plant densities. Significant mortality may occur under the ice in the dredged areas. Biomass accumulation increased in the lake as the water temperature approached 10 C, and the plant had the ability to funnel its resources in a low-light habitat into relatively few rapidly elongating shoots which could gain access to the higher light intensities near the surface. In Collins Lake, the lowered light intensity produced by the dredging to 3.3 m apparently was a major factor contributing to the resulting control of P. crispus. Some plants did reach the surface of the lake, but they were scattered and much less vigorous than plants in the undredged area. Shallow dredging to control P. crispus would likely fail except under conditions of very low water transparency. (Baker-IVI)
W85-05523

ESTIMATION IN PARTIAL DURATION SERIES WITH INDEPENDENT AND DEPENDENT PEAK VALUES,
Technical Univ. of Denmark, Lyngby. Inst. of Hydrodynamics and Hydraulic Engineering.
D. Rosbjerg.
Journal of Hydrology, Vol. 76, No. 1/2, p 183-195, January, 1985. 7 Fig, 5 Ref.

Descriptors: *Hydrographs, *Estimating, *Flood frequency analysis, Flood control, Floods, Runoff, Monte Carlo Method.

Partial duration series with exponentially distributed peak exceedance values and Poissonian occurence times were studied in the case of both independent and dependent peak values. Especially the variance of the T-yr estimate was considered. In the case of independent peak values a formula for the variance of the T-yr estimate was developed. It contains a correction factor that accounts for the previously unexplained deviations between theory-based and Monte Carlo-based variance calculations. In the dependent case a formula for the variance of the T-yr estimate has been developed and shown to be in fine agreement with Monte Carlo based variance calculations. In the case of dependent peak values a general formula for the distribution function of the annual maximum values has been obtained. The use of the formula was exemplified, and values of the correlation coefficient between successive peak values were taken into account. (Baker-IVI)
W85-05540

IMPORTANCE OF STREAMSIDE FORESTS TO LARGE RIVERS: THE ISOLATION OF THE WILLAMETTE RIVER, OREGON, U.S.A., FROM ITS FLOODPLAIN BY SNAGGING AND STREAMSIDE FOREST REMOVAL,
Pacific Northwest Forest and Range Experiment Station, Corvallis, OR. Forestry Sciences Lab.
For primary bibliographic entry see Field 6G.
W85-05663

MANAGEMENT OF DITCHES. THE EFFECT OF CLEANING OF DITCHES ON THE WATER COENOSES,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Landscape Ecology and Nature Management.
For primary bibliographic entry see Field 6G.
W85-05682

4B. Groundwater Management

ENGINEERING ECONOMIC ANALYSIS OF A PROGRAM FOR ARTIFICIAL GROUNDWATER RECHARGE,
Geological Survey, Menlo Park, CA. Water Resources Div.
E. G. Reichard, and J. D. Bredehoeft.
Water Resources Bulletin, Vol. 20, No. 6, p 929-939, December, 1984. 8 Fig, 3 Tab, 27 Ref.

Descriptors: *Groundwater recharge, *Economic aspects, *Recharge, *Santa Clara Valley, *California, Costs, Cost-benefit analysis, Percolation, Model studies.

Two alternate methods are presented for evaluating the relative costs and benefits of artificial groundwater recharge using percolation ponds. The first analysis considers the benefits to be the reduction of pumping lifts and land subsidence; the second considers benefits as the alternative costs of a comparable surface delivery system. Example computations are carried out for an existing artificial recharge program in Santa Clara Valley in California. A computer groundwater model is used to estimate both the average long term and the drought period effects of artificial recharge in the study area. For the example problem, the benefits of reduced average annual pumping lifts and reduced incremental subsidence are greater than the total costs of continuing the existing artificial recharge program. Benefits for reduced subsidence are strongly dependent on initial aquifer conditions. The second analysis compares the cost of continuing the artificial recharge program with the costs of a surface system which would achieve the same hydraulic effects. Results indicate that the costs of artificial recharge are considerably smaller than the alternative costs of an equivalent surface system. In evaluating a particular program, consideration should also be given to uncertainties in future supplies and demands for water as well as to the probability of extreme events such as droughts. (Author's abstract)
W85-05001

ANALYTICAL SOLUTION TO THE PROBLEM OF SEEPAGE INTO COUNTERFORT DRAINS,
Kingston Polytechnic, Kingston upon Thames (England). School of Civil Engineering.
For primary bibliographic entry see Field 2G.
W85-05528

HYDRAULIC GRADIENT CONTROL FOR GROUNDWATER CONTAMINANT REMOVAL,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5F.
W85-05533

4C. Effects On Water Of Man's Non-Water Activities

COMPARATIVE ANALYSES OF FISH POPULATIONS IN NATURALLY ACIDIC AND CIRCUMNEUTRAL LAKES IN NORTHERN WISCONSIN,
Columbia National Fisheries Research Lab., La Crosse, WI. Field Research Station
For primary bibliographic entry see Field 5C.
W85-05132

EFFECT OF DISTURBED SOIL THICKNESS ON SOIL WATER USE AND MOVEMENT UNDER PERENNIAL GRASS,
Science and Education Administration, Mandan, ND. Northern Great Plains Research Center.
For primary bibliographic entry see Field 2I.
W85-05190

ICE JAM PREDICTION MODEL AS A TOOL IN FLOODPLAIN MANAGEMENT,

State Univ. of New York at Binghamton. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2C.
W85-05504

SIMULATION OF CHANGES IN GROUND-WATER LEVELS ASSOCIATED WITH STRIP MINING,
Alberta Univ., Edmonton. Dept. of Geology.
F. W. Schwartz, and A. S. Crowe.
Geological Society of America Bulletin, Vol. 96, No. 2, p 253-262, February, 1985. 5 Fig, 2 Tab, 47 Ref.

Descriptors: *Strip mines, *Groundwater level, *Simulation, Mathematical models, Water table, Seepage, Permeability coefficient, Hydrogeology, Groundwater recharge, Storativity, Strip mine wastes.

Coal strip mining can influence ground-water levels both spatially and in time in the vicinity of a mine. The magnitude, extent, and timing of such changes ae not, however, well known. Through the use of a finite element model that was developed specifically to study these problems, it is possible to solve for the hydraulic-head distribution within a two-dimensional region and for the position of the water table and seepage faces in a mined area as a function of time. Sensitivity analyses conducted with the model show that strip mining not only influences water levels during the mining and early post-mining period but also show that the most significant effects are observed during re-establishment of a steady-state flow system following mining. The magnitude and extent of changes in ground-water levels are controlled by at least four important hydrogeological parameters: (1) the presence of local discharge areas or sources of recharge, (2) the character of the post-mining landscape, (3) changes in the rate of recharge through the spoil, and (4) changes in the hydraulic conductivity of the spoil relative to the undisturbed geologic materials. The timing of water-level changes depends upon features of the flow system, such as how efficiently water is able to move to the low in hydraulic potential, caused by mining, and also upon the storativity of the mine spoil. All of the simulations indicate that long times are required for the flow system to re-establish steady-state conditions following mining. Such results imply that the maximum impact of mining at some sites may not be felt until many years following the cessation of mining. (Author's abstract)
W85-05731

4D. Watershed Protection

ROLE OF FORESTRY IN DRY AFRICA,
Massachusetts Univ., Amherst. Dept. of Forestry and Wildlife Management.
P. A. Harou, W. A. Patterson III, and J. Falconi.
Journal of Forestry, Vol. 83, No. 3, p 142-147, March, 1985. 4 Fig, 16 Ref.

Descriptors: *Africa, *Forestry, *Arid regions, *Drought, Overpopulation, Forest management, Sahel, Irrigation, Deforestation, Grazing, Deserts, Erosion control, Watershed protection.

Recent deforestation in Africa is a result of two primary factors: drought, and increased human pressure on the resource base. The great variability in both seasonal and annual pecipitation is the most important climatic feature of these dry-land ecosystems. Unreliable rainfall and unfertile soil make the major land uses - agriculture, forestry and range management - marginal on any given site. The soils are prone to quick deterioration when mismanaged. Human influences have contributed to the degradation of vegetation in the Sahel. The forester must act within the existing climatic constraints to prevent an irreversible deterioration of the environment. Problems can occur due to escaping fires, overgrazing, and tree cutting for fuel and timber. Views on how woody vegetation should be managed in arid regions like the Sahel are discussed. The two alternatives for using trees to restore vegetation encompass a variety of activities directed at restoring vegetative cover and improving grazing and agricultural productivity. In areas where irrigation can be practiced, both cultivation and tree plantations are possible. (Baker-IVI)
W85-05467

QUANTITATIVE ANALYSIS OF DEBRIS TORRENT HAZARDS FOR DESIGN OF REMEDIAL MEASURES,
Thurber Consultants Ltd., Vancouver (British Columbia).
For primary bibliographic entry see Field 2J.
W85-05529

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

PORTABLE MONITOR FOR MEASUREMENT OF DISSOLVED SULFIDE BASED ON THE GLASS/SULFIDE-SELECTIVE ELECTRODE COUPLE,
Atomic Energy of Canada Ltd., Chalk River (Ontario).
For primary bibliographic entry see Field 7B.
W85-04975

MUTAGENIC ACTIVITY IN ORGANIC CONCENTRATE FROM NISHITAKASE RIVER WATER IN KYOTO CITY, AND ITS FRACTIONS SEPARATED BY USING LIQUID-LIQUID FRACTIONATION AND THIN LAYER CHROMATOGRAPHY,
Kyoto City Inst. of Public Health (Japan).
S. Maruoka, S. Yamanaka, and Y. Yamamoto.
Water Research, Vol. 19, No. 2, p 249-256, 1985. 9 Fig, 3 Tab, 22 Ref.

Descriptors: *Mutagens, *Nishitakase River, *Kyoto City, *Japan, *Thin layer chromatography, *Liquid-liquid fractionation, Water pollution effects.

XAD adsorption followed by elution with ethyl ether was used for recovering mutagenic substances from Nishitakase River water in Kyoto City. XAD extract recovered was separated by acid-base-neutral fractionation and tested for mutagenicity by using TA 1538 as a tester strain. The XAD extract showed strong mutagenic activity in the presence of S-9 mix, indicating the presence of frameshift type promutagens in the river water. Of the fractions separated, the neutral and basic fraction exhibited much more pronounced mutagenic activity and their contribution accounted for 98% of the mutagenic activity of the XAD extract. In order to separate mutagenic components, these active fractions were submitted to thin layer chromatography (TLC). In total 14 TLC subfractions, which had the ability to induce more than 100 net revertants/100 micro g of the neutral fraction or 10 micro g of the basic fraction, were isolated after 2 consecutive thin layer chromatographies. The importance of varying S-9 concentration in the S-9 mix is also discussed to determine the presence or absence of synergical/antagonistic effect of chemical constituents of complex mixtures like the XAD extract. (Author's abstract)
W85-04980

ULTRAFILTRATION PROCESSES FOR THE CHARACTERIZATION AND SEPARATION OF LANDFILL LEACHATES,
Manhattan Coll., Bronx, NY. Dept. of Chemical Engineering.
C. S. Slater, C. G. Uchrin, and R. C. Ahlert.
Journal of Environmental Science and Health, Vol. A20, No. 1, p 97-111, January, 1985. 9 Fig, 1 Tab, 17 Ref.

Descriptors: *Wastewater treatment, *Leachates, *Ultrafiltration, *Landfills, *Chemical analysis, Organic matter, Filtration, Lime.

Ultrafiltration is demonstrated to be an effective method for characterizing industrial landfill leachates by molecular weight (MW) distribution. The majority of the organic matter (as TOC and COD) for the hazardous wastes examined was found to be below 500 MW. The applicability of ultrafiltration as an effective process for removal of low MW organic matter from industrial wastes is limited. Ultrafiltration, however, is useful as a pretreatment process for removal of large MW compounds that interfere with subsequent treatment processes. Ultrafiltration of raw landfill leachates is hindered by concentration polarization and severe fouling. Physiochemical lime treatment of the highly turbid raw leachate was found to aid in the stabilization of product flux. (Author's abstract)
W85-04985

GAS CHROMATOGRAPHIC-MASS SPECTROMETRIC INVESTIGATIONS ON LIPOPHILIC ANTHROPOGENIC SUBSTANCES IN MARINE ORGANISMS; I. A CLEAN-UP-PROCEDURE CONSISTING OF LIQUID-LIQUID AND REVERSED PHASE (OCTADECYL)-PARTITIONING,
Biologische Anstalt Helgoland (Germany, F.R.)
K. R. Sperling, D. Janssen, and T. Wulf.
Fresenius's Zeitschrift fur Analytische Chemie, Vol. 320, p 1-5, January, 1985. 3 Fig, 19 Ref.

Descriptors: *Gas chromatography, *Mass spectrometry, *Lipophilic substances, *Tissue analysis, *Cleanup procedures, *Liquid-liquid partitioning, *Reversed phase partitioning, Chemical analysis, Dimethylformamide, Octadecyl partitioning, Pesticides, Halogenated organics.

Methods are needed for the trace analytical identification of anthropogenic substances in marine matrices. Here we are mainly concerned with lipophilic compounds which may be enriched through food chains and, thus, represent a potential danger. Their investigation by capillary gas chromatography-mass spectrometry is difficult as it requires a very efficient previous separation from a matrix of lipids which accompany them due to their similar chemical nature. Clean-up methods which are usual for the determination of the 'classical' organohalogen compounds were insufficient. The ECD detector descriminates large excesses of lipids from the matrix. But the latter falsifies the mass spectra of the relevant substances completely. Several combinations of clean-up methods were checked. One of them proved to be extraordinarily effective. It consists of a liquid-liquid partitioning between dimethylformamide (DMF) and hexane followed by a reversed phase (octadecyl) partitioning. By its application, organohalogenides from commercial cod-liver oil could be separated in a capillary gas chromatograph and identified by mass spectrometry. Remarkable is that more alpha-HCH is present than gamma-HCH as the latter is a pesticide and the former merely its (more toxic) by-product. Similary, DDT's are only present in minute amounts, whereas p,p' DDE, the main degradation product, produced the main peak. Furthermore, various PCB's, toxaphenes and chlordanes were present in significant amounts. (Author's abstract)
W85-04986

IDENTIFICATION OF ASBESTOS AND GLASS FIBERS IN MUNICIPAL SEWAGE SLUDGES,
Minnesota Dept. of Health, Minneapolis.
K. Bishop, S. J. Ring, T. Zoltai, C. G. Manos, and V. D. Ahrens.
Bulletin of Environmental Contamination and Toxicology, Vol. 34, No. 3, p 301-308, March, 1985. 2 Tab, 30 Ref.

Descriptors: *Asbestos, *Sludge, *Municipal wastes, Public health, Occupations, Human diseases.

Municipal sludge samples from five large American cities were examined for the presence of asbestos fibers. The possible toxicologic significance of the findings for specific occupational groups is discussed. No evidence was found for the presence of asbestos fibers in any of the sludge samples by x-

ray diffraction analysis using the Philips x-ray diffractometer, possibly due to the limits of detection of this method. Only the sludge sample from Los Angeles was subjected to electron microscopic analysis. The two amphibole fibers identified in the first replicate of the sample were both tremolite. It is difficult to assess the health significance of the presence of asbestos or glass fibers in single sludge samples. What the exposure level and health effects would be to workers employed in preparation of dry, bagged sludge products for sale or those applying such products in floricultural or horticultural work is unknown. This would depend on many factors including the concentration and types of asbestos fibers present in the air, the simultaneous presence of other toxicants and pathogens which may exacerbate asbestos toxicity, volume of air inhaled, times of exposure, the use of protective respiratory devices and the susceptibility of the individual. (Baker-IVI)
W85-05008

EFFECT OF BACTERIAL CULTURES ON MICROBIAL TOXICITY ASSESSMENT,
National Water Research Inst., Burlington (Ontario). Environmental Contaminants Div.
D. Liu.
Bulletin of Environmental Contamination and Toxicology, Vol. 34, No. 3, p 331-339, March, 1985. 4 Tab, 23 Ref.

Descriptors: *Bacteria, *Cultures, *Toxicity, Microbial toxicity test, Water analysis, Pollutant identification.

The effect of various bacterial species on the microbial toxicity test using 6 different bacterial cultures, 12 selected chemicals and a standard set of conditions was examined. Perhaps the most important public health aspect of this study is the finding that a chemical's toxicity seems to vary dramatically from one species to another, even assayed by the same testing procedure. The extreme complexity and unpredictability of the biota-toxicant interaction is demonstrated. The diverse responses of bacterial cultures to different concentrations of the same chemical would also suggest that the linear dose-response models often used to explain toxicological responses are inadequate in ecotoxicological research on toxic substances in the natural environment. Apparently, it is not appropriate to assess the toxicity of a chemical by a single bacterial species. Thus, the battery approach involving the use of at least two or more bacterial species with the test chemical assayed at a wide range of concentrations to yield both acute and subtile effects is recommended. (Baker-IVI)
W85-05009

INCREASED RESPONSE OF THE RAINBOW TROUT GONAD CELL UNSCHEDULED DNA REPAIR ASSAY,
British Columbia Cancer Research Center, Vancouver. Environmental Carcinogenesis Unit.
D. G. Walton, A. B. Acton, and H. F. Stich.
Bulletin of Environmental Contamination and Toxicology, Vol. 34, No. 3, p 340-348, March, 1985. 5 Fig, 37 Ref.

Descriptors: *Testing procedures, *Toxicity, *Trout, *Unscheduled DNA repair, Fish, Organic compounds, Carcinogens, Mutagens, Bioassay.

In mammalian test systems, the UDS technique has proven to have in vivo and in vitro applications and responds to many classes of carcinogens. Data are presented which demonstrate how the in vitro UDS assay with rainbow trout gonad (RTG) cells may be modified to enhance grain production, thus increasing the sensitivity of the assay. Extending the 3HTdR treatment period to 6 hr resulted in higher grain counts. Presumably, a longer treatment period permits more DNA to be repaired, hence 3HTdR incorporation. No toxic effects were noted with the longer 3HTdR exposure. Grain count increases were not proportional to increases in 3HTdR exposure. Increasing the duration of exposure to the emulsion also yielded an increase in nuclear grain count. Increased grain production was found by lengthening the duration of carcinogen exposure to about 30 min. Other factors investigated, including varying the cell division arrest time in 2.5% ADM prior to mutagen exposure, increasing the culture media's fetal calf serum concentration, varying the 3HTdR concentration, and using RTG cells differing by an excess of 30 passages, had little effect on the observed level of UDS. By conducting the assay at 25 C instead of 18 C, increasing the 3HTdR treatment period from 3 to 6 hr, and extending the emulsion exposure period from 18 to 30 days, grain production in RTG cells can be increased two to threefold. Background grain counts, observed to increase slightly, were minimized by using a low cell density on each cover slip and by thorough rinsing of the coverslip during the preservation procedure to remove non-incorporated 3HTdR. (Baker-IVI)
W85-05010

GILL DAMAGE AS A DETERMINANT OF RESIDUAL OXYGEN CONCENTRATION IN THE SEALED JAR TEST,
Helsinki Univ. (Finland). Dept. of Zoology.
H. Tuurala, M. Nikinmaa, and A. Soivio.
Bulletin of Environmental Contamination and Toxicology, Vol. 34, No. 3, p 385-389, March, 1985. 3 Tab, 8 Ref.

Descriptors: *Fish, *Sealed jar test, *Gills, *Bioassay, *Residual oxygen, Toxicity, Oxygen, Respiration, Temperature effects.

The residual oxygen bioassay or sealed jar test is used as a rapid, simple means for measuring effects of toxicants on the ability of fish to withstand oxygen depletion. Additionally, the role of gill damage was investigated in determining the residual oxygen concentration by ligating gill arches, thus limiting effective gill surface area, and carrying out sealed jar tests in clean water. Tests were carried out at different temperatures to determine if tissue oxygen consumption may influence the residual oxygen concentration. Gill damage seemed to be the major determinant of residual oxygen concentration in the sealed jar test. No change in residual oxygen concentration was noted when fish were placed in sealed jars and allowed to use oxygen from clean water at different temperatures. In contrast, clear increases in residual oxygen concentration were obtained by decreasing effective gill surface area via ligation of gill arches. Thus the different effects of toxicants in the sealed jar tests at different temperatures may rather reflect the different time course of gill damage at different temperatures. It is suggested that residual oxygen test gives mainly an indication of the effect of toxicants on gill structure, and that the accuracy of the test is dependent on the speed of changes in the effective gill area. (Baker-IVI)
W85-05015

PHYTOPLANKTON CONSTITUENTS AS INDICATOR OF WATER QUALITY: A STUDY OF THE RIVER CAUVERY,
Bangalore Univ. (India). Dept. of Botany.
R. K. Somashekar.
International Journal of Environmental Studies, Vol. 23, No. 3/4, p 209-215, October, 1984. 4 Tab, 10 Ref.

Descriptors: *Phytoplankton, *Water quality, *River Cauvery, *India, Pollution load, Algae, Diatoms, Chlorophyta, Cyanophyta, Euglenophyta, Bioindicators.

Phytoplankton and water samples were collected from four stations on the river Cauvery, over a distance of 20 km, 16 km away from Mysore City, Karnakataka, India. The stations, representing different degrees of pollution, were investigated hydrobiologically to find dependable criteria for pollution levels. There is significant difference in the distribution pattern of different algal groups between the polluted and unpolluted stations. Comparatively larger numbers of green algae and diatoms were observed at the unpolluted station. Cyanophyceae dominated at the polluted stations. Euglenophytes were collected mostly from the polluted stations and the number at the unpolluted station was almost insignificant. Species encountered at different stations were enumerated and their relative tolerance to various physicochemical factors was assessed. The relative proportion of the constituent algal class in the phytoplankton could be used for evaluating the quality of water. (Baker-IVI)
W85-05030

BIOLOGICAL ASSESSMENT OF WATER POLLUTION: A STUDY OF THE RIVER KAPILA,
Bangalore Univ. (India). Dept. of Botany.
R. K. Somashekar, and S. N. Ramaswamy.
International Journal of Environmental Studies, Vol. 23, No. 3/4, p 261-267, October, 1984. 6 Tab, 14 Ref.

Descriptors: *Water analysis, *River Kapila, *India, *Bioindicators, Water pollution, Water quality, Algae, Monitoring.

An attempt was made to assess the feasibility of application of biological data to evaluate and monitor water pollution of the river Kapila, near Nanjangud, Karnataka. The pH of samples at all the stations remained on the alkaline side. Water samples at pollution stations contained higher amounts of oxidizable organic matter and the BOD was high. Station 3 recorded the lowest number of species and total algae, perhaps because of the toxicity of complex physico-chemical factors. The effluents released from the paper mill contain nitrogen complex, phosphates, silicates, sodium and potassium which, in fact, constitute the nutrients of the algae. Two pollution index factors, one at the generic level and another at species level of the algae were computed. Significant correlations were noted between biological and some physicochemical factors have been established. (Baker-IVI)
W85-05033

METHOD FOR THE DETERMINATION OF COD OF LOW LOADED WATERS (EINE CSB-METHODE FUR GERING BELASTETE WASSER),
Stuttgart Univ. (Germany, F.R.). Inst. fuer Siedlungswasserbau, Wassergutewirtschaft und Abfalltechnik.
R. Wagner, and W. Ruck.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 17, p 268-272, 1984. 2 Fig, 2 Tab, 11 Ref.

Descriptors: *Chemical analysis, *Chemical oxygen demand, *Oxygen demand, Chlorides, Hydrogen chloride, Silver sulfate, Sulfuric acid, Potassium dichromate, Amino acetic acid, Nicotinic acid.

A method is presented for the determination of low values of COD (1-15 mg/l). This method includes the step of complete removal of chloride ions as hydrogen chloride by diffusion and uses a silver sulfate containing solution of potassium dichromate in concentrated sulfuric acid as oxidizing agent. Despite of the low concentration level many organic compounds are completely oxidized, for amino acetic acid and nicotinic acid - two more recalcitrant compounds - oxidation rates of 93.5 and 57%, respectively, were found. The investigations concerning the chloride problem are extended to concentrations up to 10,000 mg/l chloride ions. (Author's abstract)
W85-05044

MODIFIED MEMBRANE-FILTER PROCEDURE FOR CONCENTRATION OF ENTEROVIRUSES FROM TAP WATER,
Florida Univ., Gainesville. Dept. of Microbiology and Cell Science.
P. A. Shields, S. A. Berenfeld, and S. R. Farrah.
Applied and Environmental Microbiology, Vol. 49, No. 2, p 453-455, February, 1985. 1 Tab, 13 Ref. EPA grant R810126-01-0.

Descriptors: *Enteroviruses, *Viruses, *Water analysis, *Membrane filters, *Drinking water, Filters, Adsorption.

Enteroviruses added to 114 liters of dechlorinated tap water were recovered in a 16-ml sample by a two-stage concentration procedure in which differ-

ent types of membrane filters were used in each concentration stage. Viruses in tap water at pH 3.5 were first adsorbed to 10-in. (ca. 25.4-cm) epoxy-fiber glass filters (Filterite). Viruses adsorbed to these filters were eluted with a solution of 0.2 M sodium trichloroaceate buffered at pH 9 with 0.2 M lysine. Viruses in this solution were adsorbed to 47-mm asbestos filters (Seitz) without pH adjustment or other modification of the solution. Viruses were recovered from the Seitz filters with 16 ml of either Casitone or fetal calf serum at pH 9. With these procedures ca. 45% of several types of enteroviruses added to 114 liters of tap water could be recovered in the final 16-ml sample. (Author's abstract)
W85-05054

USE OF SIMPLE KINETIC MODELS TO HELP DESIGN ENVIRONMENTAL MONITORING SYSTEMS,
EG and G Idaho, Inc., Idaho Falls.
G. B. Wiersma, C. W. Frank, M. J. Case, and A. B. Crockett.
Environmental Monitoring and Assessment, Vol. 4, p 233-255, September, 1984. 3 Fig, 9 Tab, 67 Ref.

Descriptors: *Model studies, *Kinetics, *Monitoring, *Water quality control, Wilderness areas, Geothermal energy, Fate of pollutants, Path of pollutants.

Simple linear models were applied to help design environmental monitoring systems. Five steps are involved: the derivation of a schematic of the identified pollutant's transport and fate, the derivation of the equation in the schematic, estimation of input data and numerical solution, comparison with initial field data, and design of a monitoring system. Two examples of how this system is applied under field conditions are given. One study was located in a national park where there was a need to develop a pollutant monitoring system for wilderness areas that are designated as Biosphere Reserves. Sources of pollutant (lead) in this model could not be directly determined because of the remoteness of the site. Surface water was identifed as the critical receptor of the lead deposits. No lead above the detection limit of 0.01 mg/l was present in any surface water samples. Lead was not detected in ground water collected from springs. The second study was conducted at a known geothermal resource area slated for energy development, to determine baseline conditions. Advantages of this approach are that it forces a consideration of the system as a whole rather than a series of distinct environmental components; it forces a consideration of the physical-chemical and biological factors affecting pollutant transport in the system, it sets up an analytical procedure for data analysis at the time the monitoring system is designed, it helps show the functional relationship between pollutant levels in different environmental media, it identified points where sampling design could be changed to provide for a more efficient monitoring system, and it identified gaps in the knowledge base. (Baker-IVI)
W85-05102

ION-CHROMATOGRAPHIC DETERMINATION OF DIVALENT METAL IONS (CO, NI, CU, ZN, CD) USING EDTA AS COMPLEXING AGENT,
Government Industrial Research Inst., Osaka, Ikeda (Japan).
T. Tanaka.
Fresenius Zeitschrift fur Analytische Chemie, Vol. 320, No. 2, p 125-127, February, 1985. 5 Fig, 2 Tab, 8 Ref.

Descriptors: *Chromatography, *Cobalt, *Nickel, *Copper, *Zinc, *Cadmium, Industrial wastes, EDTA, Pollutant identification, Metals, Wastewater analysis.

The determination of divalent transition metal ions, such as cobalt, nickel, copper, zinc, and cadmium, is described using an ion-chromatograph equipped with an anion separator system. The metal ions were separated as the anionic metal comlexes by addition of EDTA to the sample solution, and the separated complexes were detected by conductivity measurement. By this method, anions and metal ions in the sample were successively determined. The method was applied to the determination of metal ions in plating solution and waste water. When the sample solution was introduced into the system, a chromatogram of anions in the sample was obtained. Then the sample solution with EDTA was introduced and a chromatogram of anions and metal-EDTA complexes was obtained. The metals were determined from the difference of the former and the latter chromatograms. (Baker-IVI)
W85-05104

ALPHA-TOCOPHERYL ACETATE AS AN INDICATOR OF MUNICIPAL WASTE CONTAMINATION IN THE ENVIRONMENT,
California Univ., Los Angeles. Dept. of Earth and Space Sciences.
R. P. Eganhouse, and I. R. Kaplan.
Environmental Science and Technology, Vol. 19, No. 3, p 282-285, March, 1985. 2 Fig, 1 Tab, 9 Ref. DOE contract EY-76-3-03-0034.

Descriptors: *Path of pollutants, *Tocopheryls, *Vitamin E, *Municipal wastewater, *Indicators, Water pollution sources.

During studies of the extractable organic matter in municipal wastes of southern California, alpha-tocopheryl acetate (vitamin E acetate) was found to be present in all of the 27 samples tested. The concentration of alpha-tocopheryl acetate in effluents receiving mainly primary treatment ranges from 6 to 25 micro g/L, whereas sludge samples contain approximately 1100 micro g/L. This compound is produced industrially for a variety of commercial purposes and can readily be distinguished from natural alpha-tocopherol which occurs only as the free alcohol. Its occurrence in municipal wastes reflects the widespread domestic use and disposal of vitamin E acetate-bearing products. Thus, when observed in the environment, the acetate derivative is an indicator of sewage contamination. An examination of sediments deposited in the vicinity of a submarine waste outfall system clearly revealed the presence of alpha-tocopheryl acetate, suggesting that this molecule can survive the earliest stages of diagenesis. (Author's abstract)
W85-05119

CONTINUOUS DETECTION OF POLLUTANTS ON SURFACES OF RUNNING WATER (KONTINUIERLICHER NACHWEIS VON VERUNREINIGUNGEN AUF OBERFLACHEN VON FLIESSENDEN GEWASSERN),
Strohlein GmbH and Co. 4044 Kaarst 1.
H. Stremming.
Wasser, Luft und Betrieb, Vol. 28, No. 4, p 14-16, April, 1984. 3 Fig.

Descriptors: *Monitoring, *Water pollution, *Oil, *Organic compounds, Fluorescence, Reflectance, Water pollution control, Optical properties, Oil pollution, Oil spills.

A new device, the Strohlein-Flucomat, provides continuous, non-contact monitoring of water surfaces to detect pollutants like oil, kerosene, and organic substances. The Flucomat has been installed to monitor inflow into pumping station of an underground collection basin at the Dusseldorf airport (Federal Republic of Germany) in order to prevent pollutants reaching the receiving stream, the Kittelbach. The device, which works optically, is robust, simple, and requires little maintenance. Gauging is achieved by means of differences in reflected light between water and pollutants floating on its surface, and by fluorescence elicited in the pollutants by ultraviolet light. By changing distance of gauge head from water and use of different optical filters, it is possible to make either one of the gauging methods dominant. By using the fluorescent mode, measurement of layer depth for certain types of oil can be made to within tenths of millimeters. Protection against interference by outside light sources is offered. The gauge head, which is hung 50 cm above the water surface, contains the ultraviolet lamp with photo element for brightness regulation and the photomultiplier with its attendant electronics. An automatic regulator is available to ensure correct distance of the head from the water in the case of variable water level. The analog gauge signal can be registered continuously in written form to document accidents, leakages, or dumping of heavily polluted wastewater. (Gish-IVI)
W85-05140

ROLE OF MYCOFLORA OF THE VOLGA AND SOME NORTHERN WATER BODIES IN PROCESSES OF SELF-PURIFICATION AND BIOINDICATION OF WATERS,
A. A. Mil'ko, and L. I. Zakharova.
Water Resources, Vol. 11, No. 2, p 129-133, March-April, 1984. 5 Tab, 16 Ref. Translated from Vodnye Resursy, No. 2, p 95-98, March-April, 1984.

Descriptors: *Aquatic plants, *Fungi, *Volga River, *USSR, Reservoirs, Lakes, Canals, Diaspores, Monitoring, Bioindicators, Water pollution.

Water samples were taken for analysis of their mycoflora content from northern water bodies (Sheksna reservoir, Northern Dvina water system, Lake Beloe, and Vodorazdel'nyi Canal) and on the cascade of Volga reservoirs from Kalinin to Astrakhan. The water of the Volga reservoirs is polluted by fungal diaspores of more than 200 species, and the northern water bodies by about 100 species. In both cases diaspores of Oomycetes and especially Fungi Imperfecti dominate. Pollution of Volga water varies within 1500-12,700 diaspores per liter and increases downstream, the larger number of diaspores being noted in the bank zone, on shallows, and in beds of higher aquatic vegetation compared with the channel. In deep stretches of the water bodies the content of diaspores in the water decreases with depth. The Volga water is more polluted with diaspores in large populated regions than far from them. The structure of mycoflora contains information about the saprobity of waters and can be used in their biomonitoring. (Baker-IVI)
W85-05156

BASIS OF BIOINDICATION OF SURFACE WATER QUALITY AT THE ORGANISMIC LEVEL,
V. A. Alekseev.
Water Resources, Vol. 11, No. 2, p 140-150, March-April, 1984. 2 Tab, 39 Ref. Translated from Vodnye Resursy, No. 2, p 107-121, March-April, 1984.

Descriptors: *Bioindicators, *Toxicity, *Water pollution effects, Water quality, Water analysis, Aquatic life, Toxobity.

Developments in aquatic toxicology are evaluated whose results are directly concerned with indication of the quality of surface waters at the organismic level. With the appearance of new anthropogenic types of of pollutants, primarily toxic, it is necessary to speak not only about saprobity but also about toxobity (the resistance of organisms to toxic pollution) and saprotoxobity (resistance of organisms to the combination of natural and toxic pollution). Of primary concern are comparative toxicological investigations whose purpose is to determine the degree of resistance of organisms of various taxonomic ranks to various toxicants. Specific topics investigated include correlation between saprobity and toxicoresistance of aquatic organisms (hydrobionts), the system of toxobity as a result of comparative toxicological taxonomic investigations, and bioindicators (oligotoxobes, beta-mesotoxobes, alpha-mesotoxobes, and polytoxobes). (Baker-IVI)
W85-05157

QUICK METHOD OF FIELD OBSERVATIONS OF WASTEWATER SPREADING IN LAKES,
G. V. Druzhinin, O. E. Korotkevich, and V. S. Rumyantsev.
Water Resources, Vol. 11, No. 2, p 169-178, March-April, 1984. 5 Fig, 6 Ref. Translated from

Vodnye Resursy, No. 2, p 150-161, March-April, 1984.

Descriptors: *Path of pollutants, *Wastewater, *Lakes, *Spatial distribution, Measuring instruments, Water analysis, Remote sensing, Data acquisition, Temporal distribution.

Investigations of the spatial distribution of wastewaters in lakes showed that domestic and industrial wastewaters move in the water column as surface, suspended or bottom layers, jets, or individual lenses and spots on the surface and at various depths. A quick method using remote electrical measurements was developed and used for studies on variable wastewater inclusions. Using this method observations were made at one point on the surface, at hydrologic stations, in the surface layer, at long term hydrologic stations, along with vertical observations and regime observations. When investigating the spreading of wastewaters in lakes the quick method is sufficient for the investigated phenomenon, as its corresponds to the statement of the problem and to the theoretical methods of its solution. The proposed method does not eliminate combined investigation with the sampling method, so that the newly obtained observations can be tied to the vast number of field observation accumulated by the discrete methods used earlier. Since the performance of in situ investigation is related to large material expenditures, any in situ investigation can and should be accurately planned beforehand. The method offers great possibilities for advance determination of the volume and type of field observations, depending on the stated problem. The notion that lake pollution occurs gradually and successively covers zones ever more distant from the discharge site is not confirmed by this study. Apparently, the need to interpolate between sampling points led to the idea of zonal spreading of wastewaters. (Baker-IVI)
W85-05161

LEACHING BEHAVIOR OF LEAD AND CADMIUM AT VARIOUS PH CONDITIONS,
Residuals Management Technology, Inc., Madison, WI.
For primary bibliographic entry see Field 5E.
W85-05370

CHEMICAL CHARACTERISTICS OF LEACHATE FROM MUNICIPAL SOLID WASTE LANDFILLS IN WISCONSON,
Wisconsin Dept. of Natural Resources, Madison. Bureau of Solid Waste Management.
For primary bibliographic entry see Field 5E.
W85-05371

POLLUTION BIOMONITORING PROGRAMS AND THE GENETIC STRUCTURE OF INDICATOR SPECIES,
Stockholm Univ. (Sweden). Inst. of Genetics.
U. Gyllensten, and N. Ryman.
Ambio, Vol. 14, No. 1, p 29-31, 1985. 3 Fig, 35 Ref.

Descriptors: *Biomonitoring, *Bioindicators, *Genetics, Fish populations, Pollutant identification, Allozymes, Sculpin, Monitoring.

How analysis of the genetic structure of a spices may contribute information important for the planning and implementation of biomonitoring programs is reviewed. The genetic effects of pollutants on natural fish populations depends on the genetically determined susceptibility of the specific populations affected. A proper assessment of the effects is not possible without knowledge of both the genetic population structure of the species and the amount of variation in genetic tolerance to the pollutant between populations. A variety of parameters have been employed to characterize populations or population segments of fish, including demographic parameters, physiological and behavioral traits, morphological and meristic characteristics, calcified structures, cytogenetic and immunogenetic characteristics, biochemical genetic characteristics, and direct estimates of DNA sequence divergence. Allozyme analysis has been conducted on many hundred species, and data are available for most taxonomic groups. The variability at loci that determine the response to pollution is of particular interest. Genetic variability in fourhorn sculpin is described in detail along with implications for biomonitoring. (Baker-IVI)
W85-05465

FISH DEFORMITIES AND POLLUTION IN SOME SWEDISH WATERS,
National Swedish Environment Protection Board, Nykoeping. Brackish Water Toxicology Lab.
For primary bibliographic entry see Field 5C.
W85-05466

CHEMICAL DERIVATIZATION ANALYSIS OF PESTICIDE RESIDUES. IX. ANALYSIS OF PHENOL AND 21 CHLORINATED PHENOLS IN NATURAL WATERS BY FORMATION OF PENTAFLUOROBENZYL ETHER DERIVATIVES,
Canada Centre for Inland Waters, Burlington (Ontario).
H.-B. Lee, L.-D. Weng, and A. S. Y. Chau.
Association of Official Analytical Chemists, Vol. 67, No. 6, p 789-794, November-December, 1984. 2 Fig, 4 Tab, 19 Ref.

Descriptors: *Pollutant identification, *Pesticide residues, *Chlorinated phenols, *Phenols, Pentafluorobenzyl ether, Chloroalkylphenols, Chromatography, Organic compounds, Surface waters, Water analysis, Natural waters.

A sensitive, isomer-specific method is described for the simultaneous and quantitative analysis of 22 phenols (phenol, 18 chlorophenols, and 3 choroalkylphenols) in natural waters. The sample was acidified to pH <2, extracted with dichloromethane, evaporated, and dissolved in acetone. The phenol extract was then reacted with pentafluorobenzyl bromide to give the PFB ether derivatives. After silica gel column cleanup, the ethers were chromatographed on a 12 m OV-1 fused silica capillary column attached to an electron capture detector. The detection limit was 0.1 ppb for 1 L samples. Recoveries of phenols from pH 2 water samples fortified at 10, 1, and 0.1 ppb were $>$ 80% in most cases except for phenol which was only 30 to 35% recovered. The extraction and PFBBr derivatization procedure presented are well suited to analysis of chlorophenols in natural waters. This method applies to the determination of higher chlorophenols in water at low ppb levels, because the ECD is equally sensitive to PFB ethers of all 22 phenols. The PFBBr derivatization technique is the method of choice if simultaneous determination of non- or monochlorinated phenols together with polychlorinated phenols at trace levels is required in the same sample. If this method is applied to higher phenol concentrations, a smaller sample should be extracted so that quantitative recovery of all 22 phenols can be maintained. Because of reagent blanks and co-extractives, the detection limit of this method is 0.1 ppb for 1 L samples. (Baker-IVI)
W85-05471

ARSENIC, CADMIUM, LEAD, MERCURY, AND SELENIUM IN SEDIMENTS OF RIVERINE AND POTHOLE WETLANDS OF THE NORTH CENTRAL UNITED STATES,
Columbia National Fisheries Research Lab., Yankton, SD. Field Research Station.
D. B. Martin, and W. A. Hartman.
Journal of the Association of Official Analytical Chemists, Vol. 67, No. 6, p 1141-1146, November/December, 1984. 1 Fig, 3 Tab, 31 Ref.

Descriptors: *Heavy metals, *Sediments, *Wetlands, Riverine wetlands, Pothole wetlands, Arsenic, Cadmium, Lead, Mercury, Selenium, Sediment contamination.

In 1980 a two year study was begun of sediments in the US Fish and Wildlife Service (USFWS) wetlands to obtain baseline information on specific element concentrations. Objectives of the study were to determine the concentrations of arsenic, cadmium, lead, mercury, and selenium in the sediments of representative riverine and pothole wetlands in the North Central US, compare these element concentrations with values from the literature, and make an initial assessment of the present state of these wetlands for possible contamination. Mean of dry weight concentrations (mg/kg) for pothole and riverine locations, respectively, were arsenic 4.4 and 2.4, cadmium 0.52 and 0.26, lead 13 and 6.6, and selenium 0.89 and 0.52. Mercury concentrations did not differ significantly between pothole sediment and riverine type wetland sediments with a mean of 0.03. With the possible exception of one location, levels found in this study were within normal or background ranges according to literature values. (Baker-IVI)
W85-05472

APPLYING ANALYTICAL TECHNIQUES TO SOLVE GROUNDWATER CONTAMINATION PROBLEMS,
Drexel Univ., Philadelphia, PA. Environmental Studies Inst.
For primary bibliographic entry see Field 5G.
W85-05478

TWO-COLUMN METHOD FOR PRECONCENTRATION OF TRACE METALS IN NATURAL WATERS ON ACRYLATE RESIN,
McMaster Univ., Hamilton (Ontario). Dept. of Chemistry.
C.-C. Wan, S. Chiang, and A. Corsini.
Analytical Chemistry, Vol. 57, No. 3, p 719-723, March, 1985. 3 Fig, 3 Tab, 27 Ref.

Descriptors: *Pollutant identification, *Trace metals, *Preconcentration, Seawater, Lake water, Iron, Copper, Nickel, Manganese, Lead, Cobalt, Cadmium, Chromium, Natural waters.

Conditions for the direct preconcentration of XAD-7 columns were determined for several trace metal ions in aqueous solutions of low and high salinity. Low breakthrough volumes in the presence of humic materials necessitated their prior removal at low pH by means of a precolumn of XAD-7. The two column procedure was applied to the determination of trace metals in seawater and lake water. The final effluent for measurement by graphite-furnace atomic absorption spectrometry is readily matrix matched and permits use of the standard calibration curve procedure for the majority of trace metals determined. This results in a reduction of sample consumption and analysis time. The effectiveness of XAD-7 columns for the direct preconcentration of trace levels of metal ions is dependent on a number of factors, including pH and flow rate, particle size, humic substances, salts, and the elution of retained metal ions. (Baker-IVI)
W85-05518

AUTOMATED IODOMETRIC METHOD FOR DETERMINATION OF TRACE CHLORATE ION USING FLOW INJECTION ANALYSIS,
Miami Univ., Oxford, OH. Dept. of Chemistry.
K. G. Miller, G. E. Pacey, and G. Gordon.
Analytical Chemistry, Vol. 57, No. 3, p 734-737, March, 1985. 1 Fig, 4 Tab, 29 Ref.

Descriptors: *Chlorates, *Flow injection analysis, *Water analysis, Drinking water, Disinfectants, Trace levels, Water quality control, Iodometry.

The National Research Council's Safe Drinking Water Committee has recommended a 7-day no adverse response level of 0.125 mg/L for chlorate. Two approaches are described for the determination of chlorate ion at levels of .00001 M and .000001 M, respectively. Both methods use the reaction of chlorate ion with iodide ion to produce iodine. High acid concentration accelerates the reaction. At high acid concentrations the oxidation of I(-) by oxygen is extremely fast. These methods were developed by using flow injection analysis which excludes air from the flow stream. Both methods exhibit excellent relative standard deviation and accuracy in the determination of unknown ClO3(-). By incorporating the method into the closed flow injection analysis system, the prob-

lem of air oxidation of iodide ion at elevated concentration of acid is eliminated. Any potential interference from chlorine dioxide and chlorite ion can be eliminated by exploiting kinetic discrimination. (Baker-IVI)
W85-05519

ESTIMATION OF ACIDITY IN RAINFALL BY ELECTRICAL CONDUCTIVITY,
Trent Univ., Peterborough (Ontario). Dept. of Chemistry.
R. A. Stairs, and J. Semmler.
Analytical Chemistry, Vol. 57, No. 3, p 740-743, March, 1985. 1 Fig, 4 Tab, 3 Ref.

Descriptors: *Acidity, *Rainfall, *Conductivity, Estimating, *Acid rain, Natural waters, Ion exchange.

Measurement of electrical conductivity of a sample of rain or other natural freshwater, and of the same sample after passage through a bed of ion exchange resin in H(+) form, allows the calculation of acidity (or alkalinity) and salinity. Results for 64 samples of rain are provided. The principle behind the method is simple. All ions contribute to the conductivity of a solution in direct proportion to their concentration in equivalents per unit volume and their equivalent conductances. A solution containing a single ionic solute, such as hydrochloric acid, requires only a single conductance measurement for analysis. Two solutes require two measurements. The second measurement is performed after the solution has been allowed to pass through a column of a strongly acidic, cation exchange resin, which will replace the sodium ions with hydrogen ions. The method as described is suitable for automation. (Baker-IVI)
W85-05520

SELECTIVE SEPARATION AND DETERMINATION OF DISSOLVED CHROMIUM SPECIES IN NATURAL WATERS BY ATOMIC ABSORPTION SPECTROMETRY,
New South Wales Inst. of Tech., Broadway (Australia). School of Chemical and Earth Sciences.
T. L. Mullins.
Analytica Chimica Acta, Vol. 165, p 97-103, November, 1984. 6 Tab, 17 Ref.

Descriptors: *Chromium, *Atomic absorption spectrometry, Pollutant identification, Harbors, Natural waters, Water pollution sources.

A procedure for determining the concentrations of dissolved chromium species in natural waters is described. The method uses a single initial separation by co-precipitation, from which both chromium(III) and chromium(VI) concentrations are determined independently. The organic contribution is then calculated by difference from a determination of the total dissolved concentration. In the water studied, total concentrations were relatively high (1-5 micro-g/l) with Cr(VI) the predominant species in all areas with one exception, where organically bound chromium was the major species. The relatively high chromium concentrations found in these six locations in the Sydney, Australia area reflect in part the use of most of the waterways in this area as industrial carriers. Lower levels found in Port Hacking reflect the primary use of the bay as a recreational area devoted particularly to the use of power and sail boats. (Baker-IVI)
W85-05524

SUPPRESSION OF INTERFERENCES IN THE DETERMINATION OF LEAD IN NATURAL AND DRINKING WATERS BY GRAPHITE-FURNACE ATOMIC ABSORPTION SPECTROMETRY,
University of Strathclyde, Glasgow (Scotland). Dept. of Pure and Applied Chemistry.
P. R. Sthapit, J. M. Ottaway, D. J. Halls, and G. S. Fell.
Analytica Chimica Acta, Vol. 165, p 121-130, November, 1984. 3 Fig, 3 Tab, 17 Ref.

Descriptors: *Lead, *Pollutant identification, *Atomic absorption spectrometry, Water analysis, Drinking water, Natural waters, Heavy metals,. Interference effects in the determination of lead in waters are examined comprehensively, both for wall atomization and platform atomization, by looking at the individual effects of the inorganic constituents of waters. Their suppression by the use of lanthanum chloride and nitric acid is examined and the effectiveness of the treatment assessed by comparison with the results obtained for the analysis by flame and flame atomic fluorescence spectrometry. The interferences are confirmed to be mainly sulfate and chloride, of which the most important chloride is magnesium chloride. Although the use of the platform was successful in decreasing sulfate interference, it did not control the other interferences and would require the use of a matrix modifier. Nitric acid essentially controlled the chloride interferences while the lanthanum removed the sulfate interference. Comparison with two other methods, flame a.a.s. after preconcentration by evaporation and flame atomic fluorescence spectrometry prove that the lanthanum-nitric acid mixture effectively overcomes the interference effect in real samples. The method proposed is simple, staightforward and rapid and has proved a satisfactory replacement for a liquid-liquid extraction/graphite furnace atomic absorption spectrometry method. (Baker-IVI)
W85-05525

DETERMINATION OF CHROMIUM(VI) IN WASTE WATER AND INDUSTRIAL EFFLUENTS BY DIFFERENTIAL PULSE POLAROGRAPHY,
Bayer A.G., Leverkusen (Germany, F.R.). Organisch-Analytisches Lab.
C. Harzdorf, and G. Janser.
Analytical Chimica Acta, Vol. 165, p 201-207, November, 1984. 3 Fig, 2 Tab, 5 Ref.

Descriptors: *Chromium, *Wastewater analysis, *Differential pulse polarograpy, *Industrial wastes, Pollutant identification, Polarography, Heavy metals.

A method is described for the determination of chromium(VI) in water and waste water. Interfering cations are separated by co-precipitation with aluminum from the phosphate-buffered solution. Differential-pulse polarographic measurement of chromium(VI) in the same background solution at pH 10 or 12 provides a lower limit of determination of 30 micro-g/l Cr(VI). No significant losses of chromium(VI) occur in the precipitation step; chromium(VI) is not susceptible to reduction by waste water constituents at the moderate pH maintained throughout the procedure. The polarographic characteristics of chromium(VI) in phosphate-buffered solution are discussed. Two polarographic peaks are obtained in the pH range 9-12, the characteristics of which depend strongly on the actual pH. Both peaks reflect the reduction of Cr(VI) to Cr(III). The peaks appear at about -0.3 and -0.9 V vs. silver/silver chloride, thus providing the option of measuring at different potentials. By this means, interference from polarographically active organic constituents can be detected and optimum conditions of measurement may be selected for different types of sample. (Baker-IVI)
W85-05526

USE OF LONG SOLIDS RETENTION TIMES TO IMPROVE THE ACTIVATED SLUDGE BIODEGRADATION OF A COMPLEX WASTE,
South Dakota School of Mines and Technology, Rapid City.
For primary bibliographic entry see Field 5D.
W85-05551

USE OF A RAPID BIOASSAY FOR ASSESSMENT OF INDUSTRIAL WASTEWATER TREATMENT EFFECTIVENESS,
Occidental Chemical Corp., Grand Island, NY.
N. A. Casseri, W.-C. Ying, and S. A. Sojka.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 867-878, 6 Fig, 6 Tab, 11 Ref.

Descriptors: *Industrial wastewater, *Toxicity, *Bioassay, *Fish, Phenols, Fathead minnows, Daphnia, Organic chemistry, Biological oxygen demand, Adsorption, Biological treatment, Chemical treatment, Evaluation, Toxic wastes.

For many wastewaters containing a large variety of pollutants, it is difficult to devise an objective means of assessing treatment effectiveness. Bioassay is sometimes preferred to complete chemical characterization for some effluents because the results are more indicative of their potential ecological impact on the receiving water. Aquatic toxicity data obtained in 45 minutes using the Beckman Microtox system, for two types of raw, partially and completely treated industrial wastewaters, were well correlated with the 48-hr Daphnia and the 96-hr fish toxicity data for the same samples. In conducting this research program, the following important advantages in using the Microtox bioassay procedure were identified: 1) it is fast; 2) it requires a small volume of sample; 3) it can accommodate unstable samples; 4) it can demonstrate toxic effect at any percentage level in a statistically significant manner; 5) its results are more reproducible; and 6) the testing organisms are ready to use with no maintenance efforts. The reductions in the Microtox toxicity in the treated samples were consistent with such reductions in TOC, COD, and some specific compounds of interest. Therefore, the Microtox bioassay can be used in evaluating the effectiveness of chemical, biological, and adsorption processes employed in treating complex industrial wastewaters.
W85-05570

USE OF SATELLITE DATA FOR MONITORING OIL SPILLS IN CANADA,
INTERA Environmental Consultants Ltd., Ottawa (Ontario).
For primary bibliographic entry see Field 7B.
W85-05578

ECOLOGICAL MONITORING OF AQUEOUS EFFLUENTS FROM PETROLEUM REFINERIES,
CONCAWE, The Hague (Netherlands).
F. G. Payne, C. Girton, W. deLigny, A. deRoocker, and A. Sirvins.
Available from the National Technical Information Service, Springfield, VA 22161, as PB83-114025, Report No. 8/82, September 1982. 56 p. 22 Fig, 12 Tab, 35 Ref. + glossary.

Descriptors: *Monitoring, *Ecological effects, *Oil refineries, *Water pollution, *Environmental effects, *Oil industry, Effluents, Wastewater analysis, Oil.

The report provides information which will allow the management of inland and coastal refineries to evaluate the need for appropriate ecological monitoring programs to study the effect of aqueous discharges on the environment into which they are discharged. The stages in the development of a monitoring program are reviewed and a description is given of some benefits that may arise from properly conducted studies. Other sections outline procedures for sampling, collection and analysis of data and describe several case histories at refinery sites in a variety of natural habitats. The report illustrates the practical contribution that an ecological monitoring program can make to overall refinery management. It is emphasized that such a program should be approached only in consultation with appropriate experts, who are unlikely to be part of normal refinery staff, and that such experts should be involved in subsequent review and updating.
W85-05582

ANALYTICAL CHEMISTRY,
National Water Research Inst., Burlington (Ontario).
E. Nagy, and W. R. Penrose.
In: Oil and Dispersants in Canadian Seas: Research Appraisal and Recommendations, EPS 3-EC-82-27, May 1982, Environmental Protection Service, Ottawa (Ontario). p 135-143.

Descriptors: *Pollutant identification, *Oil pollution, *Separation techniques, *Oil, *Path of pollutants, *Dispersants, *Fate of pollutants, *Water pollution sources, Gas chromatography, Water analysis, Thin layer chromatography, Chromatography, Quantitative analysis, Infrared spectroscopy, Biotransformation, Bioaccumulation, Hydrocarbons.

Over the past ten years, research on analysis of petroleum in environmental samples has been centered on the development of methods to identify oil spill sources (fingerprinting). Increasing emphasis has also been placed on the development of analytical methods used in the studies of specific pathways, biotransformation and bioaccumulation processes in terrestrial, marine and freshwater ecosystem. Sampling for oil pollution is carried out by methods which are used in the sampling of other environmental contaminants. Some samples may require filtration before extraction. Most samples (except direct GC injection and purging of hydrocarbons) are concentrated before solvent extraction. The most commonly used methods of analysis are infrared or fluorescence spectrometry. Gas chromatography is useful in monitoring the dissappearance of paraffins by bacteria while column chromatography has been used to separate alkanes, aromatic and polar compounds. High pressure liquid chromatography has been used in the analysis of polyaromatic hydrocarbons in seawater, sediment and biological tissue. Volatile petroleum hydrocarbons may be detected by gas chromatography. Most dispersants are extractable into organic solvents and may be analyzed qualitatively by IR spectroscopy or thin-layer chromatography. Quantitative analysis of dispersants can be accomplished by gas chromatograpy. Fingerprinting of dispersants should be tested under field conditions.
W85-05593

CHARACTERIZATION AND TREATABILITY OF DRAINAGE SAMPLES FROM COAL PILES AT STEAM ELECTRIC POWER STATION.
Dearborn Environmental Consulting Services, Mississauga (Ontario).
Report No. EPS 3-WP-82-4, August 1982. 159 p, 18 Fig, 56 Tab, 5 Append, 49 Ref.

Descriptors: *Waste characteristics, *Wastewater treatment, *Electric powerplants, *Coal, *Piles, Electric power, Field tests, Coal piles, Drainage, Drainage water, Coke piles.

This study was conducted to illustrate characteristics and treatability of drainage from coal piles at Canadian steam electric generating stations and coke piles at Canadian steel mills. A review of the technical literature was conducted, followed by selective field sampling, analyses and bench-scale treatability studies. The factors governing coal pile drainage characteristics were determined to be the type and properties of the stored coal, meteorological conditions, and coal pile management practices. For the study, discharges from coal piles at five steam electric generating stations and two coke piles at steel-making facilities were sampled, analyzed, and evaluated for treatment. It was concluded that the coal pile drainage samples could be successfully treated to meet the criteria applied in this study using relatively simple physical-chemical treatment technology. The most cost-effective treatment for the eastern coal pile drainage sample was determined to be pH adjustment using lime and the addition of an anionic polyelectrolyte as a coagulant aid. Successful treatment of the western coal pile drainage samples involved the addition of either calcium chloride or lime as a primary coagulant. In some instances, an anionic polyelectrolyte was required to improve settling. The most cost-effective treatment method would depend on the characteristics of the specific coal pile drainage.
W85-05594

RAPID AND SENSITIVE AUTOMATED DETERMINATION OF PHOSPHATE IN NATURAL WATERS,
Malaga Univ. (Spain). Dept. de Ecologia.
J. A. Fernandez, F. X. Niell, and J. Lucena.
Limnology and Oceanography, Vol. 30, No. 1, p 227-230, January, 1985. 5 Fig, 2 Tab, 9 Ref.

Descriptors: *Phosphates, *Water analysis, *Pollutant identification, Chemical analysis, Malachite green oxalate, Detergents, Surface waters, Seawater.

A method is described for the determination of phosphate in natural waters using the basic dye malachite green oxalate and the detergent Flaminox which stabilizes the dye-phosphomolybdate complex and is a wetting agent in the automatic system. The method was automated by means of a Technicon AutoAnalyzer II. The method is linear even below 0.1 micro-g atom P/liter if a 5-cm absorption cell is used. It shows very good reproducibility. Known amounts of silicate and arsenate were added to low nutrient seawater and the interference studied. Interference caused by silcates can be removed by adding an acid line to the circuit. That produced by arsenate is controlled by adding a sodium thiosulfate line. The major problem in automating the method was the detergent. (Baker-IVI)
W85-05622

AUTOMATED FISH RESPIRATORY MONITORING SYSTEM FOR STREAM ACIDIFICATION EPISODE ASSESSMENT,
Tennessee Technological Univ., Cookeville. Cumberland Biological Station.
E. L. Morgan, and R. C. Young.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1432-1435, December, 1984. 1 Tab, 15 Ref.

Descriptors: *Acidification, *Fish behavior, *Measuring instruments, Water pollution effects, Acidity, Streams, Water quality, Hydrogen ion concentration, Acid rain, Monitoring, Trout, Bluegill.

Physiological and behavioral responses of fish have been measured in the laboratory as a means of detecting dose-dependent stress resulting from acidification. Providing validation of cause/effect responses from fish subjected to increasing stream acidification by evaluating surface water quality data in light of site-specific derived biological values would be an important complement to monitoring programs. In meeting this goal, an automated biosensing monitor was developed for monitoring fish ventilatory (breathing) rates in response to natural and experimental changes in water quality characteristics affected by acidification. Utilizing floating dock facilities and a stream-side mobile laboratory, fish breathing rate detectors were interfaced to a minicomputer for continuously generating physiological response data simultaneously with chemical/physical information. Following a series of simulated acid rainfall hydrographic episodes, rainbow trout and bluegill sunfish showed pronounced initial changes in breathing rates after several hours exposure to peak pH shifts from 7.2 to 4.5. (Baker-IVI)
W85-05629

PROBLEMS ASSOCIATED WITH SULPHATE DETERMINATION IN COLORED, HUMIC WATERS IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA (CANADA),
Canadian Wildlife Service, Halifax (Nova Scotia).
J. Kerekes, G. Howell, and T. Pollock.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1811-1817, December, 1984. 7 Fig, 1 Tab, 10 Ref.

Descriptors: *Pollutant identification, *Sulfates, *Kejimkujik National Park, *Nova Scotia, Methyl thymol blue analysis, Ion chromatography, Humic acid, Organic compounds, Acidification.

Water samples from the tributaries of Kejimkujik Lake and the outflow of Beaverskin Lake in Kejimkujik National Park, Nova Scotia are discussed. The sulfate concentrations were determined with both the methyl thymol blue (MTB) method and the ion-chromatography (IC) method. The latter method gave consistently lower sulfate values in colored, humic waters which led to an overabundance of cations. This suggests the presence of organic anions, previously masked by the apparently high sulfate concentration obtained by the MTB method. When the estimated organic anion concentrations are included in the charge balance with the ion-chromatography sulfate determinations, good balances are obtained. The five streams sampled represent a wide range of water color and show varied seasonal patterns of sulfate concentrations. There was an excellent relationship determined between color and dissolved organic carbon concentrations in Kejimkujik waters. It is cautioned that water chemistry, as it relates to acidification, cannot be considered successfully without an adequate treatment of the organic anions present which contribute to the acidity of dilute colored, humic waters. (Baker-IVI)
W85-05661

INFLUENCE OF CURRENT VELOCITY ON PERIPHYTON DISTRIBUTION AND SUCCESSION IN A NORWEGIAN SOFT WATER RIVER,
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 2H.
W85-05677

ACIDIFICATION AND EARLY WARNING ORGANISMS IN FRESHWATER IN WESTERN NORWAY,
Bergen Univ. (Norway). Zoological Museum.
G. G. Raddum, and A. Fjellheim.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1973-1980, December, 1984. 5 Fig, 1 Tab, 21 Ref.

Descriptors: *Acidification, *Norway, *Invertebrates, *Bioindicators, Monitoring, Acid rain, Water quality, Water pollution effects, Lakes, Rivers, Aquatic insects, Calcium, Aluminum, Hydrogen ion concentration.

Benthic invertebrates were sampled during the ongoing monitoring of acidified rivers and other studies carried out in southern and western Norway. The water chemistry results indicate that the water was characterized by low concentrations of dissolved salts. The northern and eastern parts of South Norway have the lowest degree of acidification. In these parts pH usually ranged between 6 and 6.5 and the conductivity between 5-30 microS/cm. The acidity increased when moving further south and west. In the most acidified areas near the coast the conductivity was higher, due to contribution from sea salts, acid deposition and increased leaching of cations from the soil and bedrock. The content of calcium was generally low, <2 mg Ca/liter. Aluminium concentration was low (<5-40 micro-g/liter) in the non-acidified regions, increasing to 100-310 micro-g/liter in the most acidified parts. The pH sensitive amphipod Gammarus lacustris was found only in the watershed of Stordalen and in the most lime-rich parts of Roldal/Suldal. Lepidurus arcticus was found in a few of the uppermost lakes of the Laerdal watershed in 1970-72 and these were the only localities holding this species currently. Snails were more common but only a few species were recorded. Of the leeches Helobdella stagnalis had the widest distribution and has one time been observed in a lake with a pH range of 4.6-5.1. The number of recorded species of stoneflies from the investigated watersheds was 21. The number of species/groups of caddisflies larvae listed is 25. Only two species of mayflies were found in the most acid water. Some siphlonurids were recorded in water with pH about 5.0. Baetis was recorded in localities with Ca <0.4 mg/l and conductivity <5.0 microS/cm at pH > 6.0. (Baker-IVI)
W85-05678

IMPROVED RECOVERY OF FECAL COLIFORMS FROM THE OTTAWA RIVER BY MEMBRANE FILTERS IN THE PRESENCE OF FOOD DEBRIS,
Health and Welfare Canada, Ottawa (Ontario). Bureau of Microbial Hazards.
J. M. Farber, A. N. Sharpe, and M. Kalab.
Canadian Journal of Microbiology, Vol. 31, No. 1, p 16-18, January, 1985. 1 Fig, 2 Tab, 7 Ref.

Group 5A—Identification Of Pollutants

Descriptors: *Membrane filters, *Fecal coliforms, *Bacterial analysis, Filtration, Membrane processes, Coliforms.

In the absence of food debris, Sartorius and Millipore HA filters recovered substantially fewer fecal coliforms from Ottawa River water than did Millipore HC. On addition of a small quantity of sterile blended carrot to water samples, recovery by the poorer filters equalled than on Millipore HC. Scanning electron microscopy revealed bacteria sheltered in crevices formed by carrots fibers and thus protected from the normal stresses of exposure. Addition of carrot debris (e.g., 0.03 g carrot to 100 mL of sample) thus provides a convenient and inexpensive means of reducing variations in fecal coliform recovery between brands of membrane filters. (Author's abstract)
W85-05741

FLUX OF LEAD IN SUBMERGED PLANTS AND ITS RELEVANCE TO A FRESHWATER SYSTEM,
Westfield Coll., London (England). Dept. of Botany.
For primary bibliographic entry see Field 5B.
W85-05745

WET DEPOSITION MONITORING - EFFECT OF SAMPLING PERIOD,
Pennsylvania State Univ., University Park. Dept. of Meteorology.
R. G. de Pena, K. C. Walker, L. Lebowitz, and J. G. Micka.
Atmospheric Environment, Vol. 19, No. 1, p 151-156, 1985. 6 Fig, 7 Tab, 2 Ref, 1 Append. NOAA and DOE contracts NA82RAC00032, NA84EAC00015(N), NA82RAC0157 and NA83RAC00087.

Descriptors: *Rainfall, *Sampling, *Wet deposition, *Acid rain, Monitoring, Ammonium, Sulfates, Nitrates, Calcium, Magnesium, Hydronium, Temperature.

A comparison between weekly and event sampling of rainfall for chemical quality has been undertaken to assess the differences in concentrations of ions introduced by different sampling periods. The data were analyzed over the period from 18 March 1981 - 28 June 1983. The weekly samples yielded lower concentrations and deposition values for all ions analyzed. The differences were significant at the 99.9% confidence level. These results cannot be explained by evaporation. The difference in the deposition depths is much lower than the difference in concentrations and in any case it would work in the opposite direction. It is suggested that some ammonia exchange takes place in the field, and that in the weekly collection there is more adsorption on the walls of the bucket. It is also suggested that the lower values obtained with the weekly collector are due to a larger biological uptake of the ions. If this is so, then the differences should be large in the summer months with higher temperatures causing an increase of biological activity. Such was the case for sulfate, ammonium and H3O(+) ions but not the case for nitrates, calcium ions and magnesium ions. (Baker-IVI)
W85-05773

GRAN'S TITRATIONS: INHERENT ERRORS IN MEASURING THE ACIDITY OF PRECIPITATION,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
W. C. Keene, and J. N. Galoway.
Atmospheric Environment, Vol. 19, No. 1, p 199-202, 1985. 2 Fig, 2 Tab, 29 Ref.

Descriptors: *Acid rain, *Sampling, *Chemistry of precipitation, *Gran's titrations, Organic compounds, Ammonia, Acidity.

Results calculated from the Gran's titration of a precipitation sample are presented and compared with the major organic and inorganic chemical constituents of the sample. These results show that the chemistry of the sample was inconsistent with acidities calculated by Gran's technique. Gran's original technique has limited applicability in the differentiation of strong and weak acidity in precipitation samples containing weak organic acids. High ammonia ion concentrations also interfere with the calculation of total acidity. Although derivation and segmented linearization techniques may work well in simple solutions, they have limitations in the analysis of precipitation containing complex mixtures of unidentified strong and weak acids. Therefore, in the absence of complete chemical characterization, data generated by Gran's technique, and related modifications, should be evaluated with caution and an appreciation of potential limitations. Ranges of errors in calculating strong acidity using Gran's method are evaluated for precipitation collected at several sites around the world. (Baker-IVI)
W85-05774

ASSESSMENT OF BACTEROIDES FRAGILIS GROUP ORGANISMS AS INDICATORS OF HUMAN FAECAL POLLUTION,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
For primary bibliographic entry see Field 5B.
W85-05808

ROLE OF IMMUNOASSAY IN THE ANALYSIS OF MICROCONTAMINANTS IN WATER SAMPLES,
Surrey Univ., Guildford (England). Dept. of Biochemistry.
G. W. Aherne, J. English, and V. Marks.
Ecotoxicology and Environmental Safety, Vol. 9, No. 1, p 79-83, February, 1985. 2 Tab, 11 Ref.

Descriptors: *Bioassays, *Water pollution effects, *Immunoassays, *Fate of pollutants, Steroids, Methotrexate, Water supply, Pollutant identification, Water pollution sources.

Concentrations of natural and synthetic steroids and an anticancer drug (methotrexate) have been determined in water by adapting established immunoassay procedures. The limits of detection for the assays used were 10 ng/liter for norethisterone, 5 ng/liter for ethinyl estradiol and progesterone, and 6.25 ng/liter for methotrexate. Results below the level of detection were obtained in all the samples examined (8 river samples and 6 potable supply samples) except for 2 river samples (17 ng/liter) for norethisterone, and 1 river sample and 1 potable water sample for progesterone (6 ng/liter). A concentration of 1 micro g/liter of methotrexate was found in a sample of hospital effluent. There appears to be no evidence of adverse effects from reused water resources which may be contaminated from the normal use of such highly active therapeutic agents. (Author's abstract)
W85-05811

EFFECTS OF VARIOUS ORGANIC CHEMICALS ON THE REGREENING OF RED COLORED CHLORELLA ZOFINGIENSIS,
Hamburg Univ. (Germany, F.R.). Inst. fuer Allgemeine Botanik.
U. Irmer, K. Heuer, and A. Weber.
Ecotoxicology and Environmental Safety, Vol. 9, No. 1, p 121-133, February, 1985. 5 Fig, 1 Tab, 34 Ref.

Descriptors: *Toxicity, *Bioassays, *Chlorella, *Plant physiology, *Water pollution effects, Organic compounds, Algae, Chlorophyll, Paraquat, Pentachlorophenol, Salt.

Under nitrogen-deficient culture conditions Chlorella zofingiensis decomposes the chlorophylls, synthesizes secondary carotenoids, and thus develops red colored resting stages (akinetes). On transfer of the akinetes into nitrogen-containing fresh culture medium the algae regreen completely within a short period. The regreening process reacts with high sensitivity to the addition of environmentally hazardous chemicals. This system proved to be much more sensitive than other methods of testing for ecotoxicity. This screening test is universally applicable and offers, in addition, the possibility of testing volatile compounds since it is carried out in air-tight culture vessels. A phytotoxicity of 50% calculated as inhibition of the chlorophyll biosynthesis during exposure for 48 hr was found for paraquat at concentrations of 0.15 micro M (added as methysulfate) and 0.28 micro M (added as chloride) and for pentachlorophenol (PCP) at 0.16 micro M. The chemicals 2- and 4-nitrophenol, however, proved to be much less toxic. Here, a 50% inhibition of chlorophyll biosynthesis was observed at 49 and 75 micro M. When exposed to 4-chloroaniline even concentrations of 200 micro M were not sufficient to cause a 50% inhibition of the regreening process, In additional experiments the influence of increasing salt concentrations (NaCl stress) and simultaneous exposure to the toxicants was examined. A step-by-step increase in the salinity of the experimental medium resulted in a drastic reduction of the toxicity caused by the addition of paraquat. This effect was much less pronounced when PCP was employed as toxicant. A different result was obtained with 2-nitrophenol: Here the toxic action was slightly enhanced. Differences in the time-dependent toxic response were also observed using the diverse toxicants. Probable causes are discussed. (Author's abstract)
W85-05814

5B. Sources Of Pollution

ELECTROCHEMICAL DETERMINATION AND CHARACTERIZATION OF SURFACE ACTIVE SUBSTANCES IN FRESHWATERS,
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.
For primary bibliographic entry see Field 2H.
W85-04972

NUMERICAL ESTUARINE FLOW MODEL,
Tulsa Univ., OK. Coll. of Engineering and Physical Sciences.
For primary bibliographic entry see Field 2L.
W85-04987

NUMERICAL MODEL OF POLLUTION TRANSPORT IN ESTUARIES,
Tulsa Univ., OK. Coll. of Engineering and Physical Sciences.
F. S. Henry, R. C. Ahlert, R. L. Peskin, and R. Vichnevetsky.
Water Resources Bulletin, Vol. 20, No. 6, p 833-839, December, 1984. 7 Fig, 16 Ref. Office of Water Research and Technology project A-044-NJ.

Descriptors: *Pollution transport, *Path of pollutants, *Estuaries, *Numerical models, *Delaware Estuary, *Pennsylvania, *New Jersey, *Delaware, Model studies, Dye releases.

Theoretical study of transport in estuaries is made difficult by the unsteady, turbulent nature of estuarine flow. A novel numerical model was developed that simulates the transport of a conservative, neutrally bouyant, dispersed pollutant in a well-mixed estuary. The model provides some two-dimensional features of pollution transport while using an essentially one-dimensional approach. The estuary's cross-section is divided into three channels running side-by-side; It is assumed that the transport of pollution in each channel can be modeled as a one-dimensional problem. The model was tested against data taken from a dye study conducted in the Delaware Estuary (Pennsylvania, New Jersey, Delaware) by the United States Environmental Protection Agency. The model was able to predict both lateral and downstream concentration profiles, and matched field data with reasonable accuracy. The model also matched an analytical solution for the transport of a contaminant in an estuary of constant cross-sectional area. (Collier-IVI)
W85-04988

SIMULATION OF HERBICIDE CONCENTRATIONS IN STORMFLOW FROM FORESTED WATERSHEDS,
Georgia Univ., Athens. School of Forest Resources.

For primary bibliographic entry see Field 2A.
W85-04991

CONTRIBUTION OF PRECIPITATION TO QUALITY OF URBAN STORM RUNOFF,
Northeastern Forest Experiment Station, Broomall, PA.
H. G. Halverson, D. R. DeWalle, and W. E. Sharpe.
Water Resources Bulletin, Vol. 20, No. 6, p 859-864, December, 1984. 5 Tab, 16 Ref.

Descriptors: *Water quality, *Urban runoff, *Storm runoff, Nitrogen, Sulfate, Phosphorus, Potassium, Calcium, Hydrogen ion concentration, Atmospheric deposition, Source of pollutants.

Precipitation and runoff samples were collected for 13 storms in a nonindustrial urban area in Central Pennsylvania between July 1980 and June 1981. Runoff was collected from tree surfaces, a residential roof and street, a shopping mall parking lot, a downtown business district alley, and a heavily traveled street. Analysis of the water samples showed 10 to 25 percent of the nitrogen, 25 percent of the sulfate, and less than 5 percent of the phosphorus, potassium, and calcium in water below a tree was deposited by the precipitation. The residential roof caused insignificant changes in water chemistry. The results for the four paved areas showed that all the nitrogen, and from 16 to 40 percent of the sulfate and 13, 4, and 2 percent of the phosphorus, potassium, and calcium, respectively, in runoff was deposited by the precipitation. Precipitation can also be an important source of sulfate and phosphorus in runoff. All of the surfaces raised the pH of the runoff, with the largest increases, from a pH of 4 to about 7, occurring in runoff from the paved areas. Precipitation and runoff chemistry was not related to antecedent conditions such as the length of the preceding dry period. (Author's abstract)
W85-04992

IDENTIFICATION OF ASBESTOS AND GLASS FIBERS IN MUNICIPAL SEWAGE SLUDGES,
Minnesota Dept. of Health, Minneapolis.
For primary bibliographic entry see Field 5A.
W85-05008

COMPETITION OF FATE PROCESSES IN THE BIOCONCENTRATION OF LINDANE,
Alberta Environmental Centre, Vegreville.
S. Ramamoorthy.
Bulletin of Environmental Contamination and Toxicology, Vol. 34, No. 3, p 349-358, March, 1958. 2 Fig, 4 Tab, 21 Ref.

Descriptors: *Fate of pollutants, *Bioconcentration, *Lindane, Organic compounds, Pesticides, Insecticides, Toxicity.

The role of sorption by natural and synthetic materials as well as volatilization on the residence time and concentration of lindane in water was investigated. The values of partition coefficients, bioconcentration factor, volatilization rate constant and the half-life for volatilizational loss from water were predicted and compared with literature values. All of the water quality parameters except metals and pH increased over the experimental period, possibly from the sediments reaching an equilibrium with the recycling river water. Fertilized eggs accumulated lindane in significant amounts and similar levels are found in sac fry exposed to very low concentrations. Sorption of lindane to sediment as well as to the surfaces of the walls of the exposure chamber was investigated. The duplicated tests show almost 30 times greater sorption by plexi-glass container than glass surface for a 10 day period. Theoretical BCF values, using lindane solubility data are calculated to be higher than the experimental value by 1000 fold. The calculated Henry's law constant of 0.202 indicated the dominance of the liquid phase resistance to lindane and thereby favors partitioning of lindane in the vapor phase. The calculated values for volatilizational rate constant and half-life for volatilizational loss from water are in reasonable agreement with the literature values, considering the widely ranging vapor pressure and aqueous solubility values for lindane reported in the literature. (Baker-IVI)
W85-05011

IDENTIFICATION AND DETERMINATION OF SOME TRACE ORGANIC COMPOUNDS IN COASTAL SEAWATER OF NORTHERN GREECE,
Thessaloniki Univ., Salonika (Greece). Environmental Pollution Control Lab.
K. Fytianos, G. Vasilikiotis, and L. Weil.
Bulletin of Environmental Contamination and Toxicology, Vol. 34, No. 3, p 390-395, March, 1985. 3 Fig, 1 Tab, 6 Ref.

Descriptors: *Organic compounds, *Water pollution sources, *Coastal waters, *Greece, Thessaloniki, Kavala, Gulfs, Oil spills, Chlorinated hydrocarbons, Pesticides, Aromatic compounds, Polychlorinated biphenyls, Marine environment.

A combination of gas chromatography - mass spectroscopy was used to identify and determine traces of organic compounds in coastal seawater samples taken from two gulfs with increased marine pollution. These gulfs were Thermaikos and Kavala, which are located in Northern Greece. The former is situated near the large city of Thesssaloniki which has a large industrial area including a refinery unit. The latter is close to a smaller city, Kavala, which is rapidly developing due to off shore oil wells. Lindane, p,p'-DDT, dieldrin and polychlorinated biphenyls were found in trace amounts. The concentration of the organochlorine compounds was higher in the harbor areas of Thessaloniki and Kavala. Polycyclic aromatic hydrocarbons were found in both unpolluted and polluted areas of the two gulfs. Some organic compounds were identified existed at a concentration range of ng/L, which is still comparatively low. However, particularly high concentrations were observed in highly industrialized regions and near the off-shore oil platform, where there is always the possibility of marine pollution, due to oil discharge. (Baker-IVI)
W85-05016

VERTICAL DISTRIBUTION OF AL, CU, FE AND ZN IN THE SOIL SALT MARSHES OF THE SADO ESTUARY, PORTUGAL,
Universidade Nova de Lisboa (Portugal). Dept. of Chemistry and Biotechnics.
F. H. S. Reboredo, and C. A. G. Ribeiro.
International Journal of Environmental Studies, Vol. 23, No. 3/4, p 249-253, October, 1984. 4 Tab, 18 Ref.

Descriptors: *Vertical distribution, *Heavy metals, *Salt marshes, *Sado Estuary, *Portugal, Fate of pollutants, Aluminum, Copper, Iron, Zinc.

Marsh soil analysis is important as a rapid evaluation factor of the pollution statur of an area. The accumulation of Al, Cu, Fe and Zn was studied in the soil cores of the coastal areas of the Sado estuary, using an acid digestion procedure and an EDTA extraction to detect the total metal content and the metal fraction easily removed, respectively. The lowest values for each metal were always observed at Station 1 which was very close to the Atlantic Ocean. Mean values observed at the other Stations (about 8.0 and 20.0 km upstream) were similar. The dilution effect at 1 is more pronounced due to the nature of the soil marsh. The dominant component at the first sampling point is the sandy fraction with about 72.5% of the total, while at the other stations the silt-clay fraction is about 85%. For Al the third core (10-15 cm deep) always presented the highest value in spite of the percentage of the silt-clay in each core remaining about constant. For Al and Fe the recovery values were similar at all sampling points, in spite of the different nature of the matrix. For Cu and Zn, the recovery values were generally lower at Station 1 and similar at the other stations. For Cu it seems unlikely that this element will be easily released from the organic matter by EDTA, since the extraction of this fraction from the matrix with strong oxidant agents and later analysis indicate that it was responsible for 40% of the total value. (Baker-IVI)
W85-05032

METALS AND CHLORINATED HYDROCARBONS IN SURFICIAL SEDIMENTS OF THREE NILE DELTA LAKES, EGYPT,
Alexandria Univ. (Egypt). Dept. of Oceanography.
For primary bibliographic entry see Field 6G.
W85-05037

RELATIONSHIP OF A COAL FIRED POWER PLANT TO THE LEVELS OF POLYCYCLIC AROMATIC HYDROCARBONS (PAH) IN THE SEDIMENT OF CAYUGA LAKE,
Department of Energy, New York. Environmental Measurements Lab.
M. Heit.
Water, Air, and Soil Pollution, Vol. 24, No. 1, p 41-61, 1985. 1 Fig, 4 Tab, 45 Ref.

Descriptors: *Powerplants, *Cayuga Lake, *New York, *Lake sediments, *Polycyclic aromatic hydrocarbons, Organic compounds, Aromatic compounds, Hydrocarbons, Water pollution sources, Wind, Coal-fired powerplants.

The relationship between a coal-fired power station to the distribution of polycyclic aromatic hydrocarbons (PAH) and related organic compounds in the sediment of Cayuga Lake, situated in the rural Finger Lakes region of New York State, is presented. Cayuga lake is 61.4 km long with a maximum width of 5.6 km and depth of 133 m. The lake was formed by glacial action and is located in a north-south oriented basin that becomes progressively steeper towards the south, resulting in a shift in the prevailing winds to movement along the axis of the lake so that emissions from the plant would be expected to pass over most of Cayuga Lake. Currents appear to be slight. The Milliken Station is a coal-fired electric generation station located about 21 km northwest of Ithaca, New York, on the east bank of Cayuga Lake. Other than for a small confined area near the stacks, the Milliken coal fired station had no discernible effect on the PAH levels in the sediment of Cayuga Lake. PAH emissions from the stacks are either very low and masked by other sources, or are atmospherically transported and deposited elsewhere. Except in the confined area near the Milliken stacks, the highest PAH concentrations measured were found in sediment taken in urban Ithaca and in various marinas along Cayuga Lake. Region wide atmospheric deposition appears to be the prime source of PAH entering the Lake, except in some areas where runoff appears to be a more important mechanism. The powerful PAH carcinogens 3-methylchloranthrene and 7,12-dimethylbenzanthracene were not detected in any samples and are thought not to be environmental hazards. No nitrogen heterocyclic PAHs were found in any of the samples. Although marinas, urbanized areas, and the Milliken powerplant all had elevated PAH levels in close proximity to them, it appears that their impacts are limited and localized. In all cases, a rapid falloff in PAH concentrations with distance from source, <100 m, was found to occur. This is in marked contrast to the uniform PAH levels found over most of the course of Cayuga Lake which reflect a region-wide pattern of deposition. (Baker-IVI)
W85-05038

SULFATE IN LAKES OF EASTERN CANADA; CALCULATED YIELDS COMPARED WITH MEASURED WET AND DRY DEPOSITION,
National Water Research Inst., Burlington (Ontario). Aquatic Physics and Systems Div.
M. E. Thompson, and M. B. Hutton.
Water, Air, and Soil Pollution, Vol. 24, No. 1, p 77-83, January, 1985. 2 Fig, 1 Tab, 18 Ref.

Descriptors: *Sulfates, *Lakes, *Atmospheric deposition, *Canada, *Acid rain, Runoff, Water pollution sources, Air pollution, Fallout.

Sulfate yields in eastern Canada, calculated as lake concentration times runoff, are presented on an

approximately west to east axis, and are compared with wet deposition data from CANSAP (Canadian Network for Sampling Precipitation) and APN (Air Pollution Network) data on dry deposition. This comparison was begun with an awareness of many possible sources of error some of which include analytical problems in measuring sulfate at low concentrations; possible terrestrial sources of sulfates; possible retention or transformation of sulfate in the watershed or in lake sediments; errors in applying regional runoff data to lakes of unknown hydrology; and variations in sample dates and sampling frequencies. For wet deposition uncertainties arise from analysis of sulfate, undercatch, evaporation, the need to interpolate between stations, and local influences on precipitation chemistry. For dry deposition the same difficulties exist with the additional problem of estimating deposition velocities. In southern Ontario and southwestern Quebec there was excellent agreement between sulfate yields and wet plus dry deposition taking the dry deposition data for Chalk River as representative. In the more remote areas, where dry deposition is less important, the agreement is also good, and this overall good agreement tends to validate both data sets. A very high sulfate yield was obtained for Lac Laflamme which may be due to its elevation. The good agreement between sulfate yields and total deposition data indicates that there is little retention of sulfate within the watersheds or in the lakes, and that most, if not all, of the sulfate in the lakes can be ascribed to atmospheric deposition. The results demonstrate the magnitude of the problem of long range transport of air pollutants and the stress that acid deposition imposes on the surface waters of eastern Canada. (Baker-IVI)
W85-05039

INTERACTIONS OF COPPER AND LEAD WITH NOSTOC MUSCORUM,
Syracuse Univ., NY. Dept. of Civil Engineering.
W. D. Schecher, and C. T. Driscoll.
Water, Air, and Soil Pollution, Vol. 24, No. 1, p 85-101, January, 1985. 1 Fig, 10 Tab, 28 Ref.

Descriptors: *Copper, *Lead, *Algae, *Fate of pollutants, *Nostoc, Accumulation, Thermodynamics, Hydrogen ion concentration, Calcium, Sulfates, Citrates, Adsorption, Bioconcentration.

The effects of variations in solution chemistry on Cu and Pb uptake by suspensions of the blue-green alga Nostoc muscorum were investigated. The thermodynamic model that was used provided a qualitative description of algal-metal interactions. In addition to the limitations that are intrinsic to all equilibrium models, the general applicability of the calculations is restricted by limited characterization of surface sites, inabilities to account for intracellular uptake of metals, and a lack of understanding of the role of extracellular exudates in algal-metal interactions. Although these interactions are complicated and dynamic, they appear to be influenced by the same thermodynamic properties that affect particles in solution. Although exceedingly simplistic, thermodynamic calculations enable us to assess the effects of pH, surface characterization, and the nature and concentration of complexing ions in solution on algal-metal interactions. The effects of pH on the uptake of Cu and Pb by N. muscorum were similar to results reported by other studies and were in basic agreement with cationic adsorption models. The release of organic exudated into solution and the presence of a mucilagenous sheath material appeared to be an important factor in regulating the distribution of the metals, and were thought to be responsible for some of the deviation between model and observed results. Calcium had a mitigating effect on metal uptake, which was thought to be due to competitive reactions between Ca and the metals for active surface sites. The presence of sulfate reduced Cu uptake by N. muscorum at pH values less than 5.6 which correlated with the theoretical formation of CuSO4 complex; and citrate decreased metal uptake by N. muscorum of both Cu and Pb, and the observed decrease was in basic agreement with model predictions. (Baker-IVI)
W85-05040

INFLUENCE OF NTA ON THE REMOBILIZATION OF METALS FROM LAKE AND RIVER SEDIMENTS (DER EINFLUSS VON NTA AUF DIE METALLRUCKLOSUNG AUS GEWASSERSEDIMENTEN),
Stuttgart Univ. (Germany, F.R.). Inst. fuer Siedlungswasserbau, Wassergutewirtschaft und Abfalltechnik.
M. Stein, and R. Wagner.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 17, p 252-262, 1984. 7 Fig, 7 Tab, 38 Ref.

Descriptors: *Nitrilotriacetic acid, *Metals, *Lake sediments, *River sediments, *Neckar River, *Lake Constance, *Germany (Federal Republic), Sediments, Aluminum, Calcium, Chromium, Lithium, Magnesium, Manganese, Lead, Iron, Phosphorus, Potassium, Barium, Nickel, Copper, Cobalt, Cadmium, Hydrogen ion concentration.

The particle-size fraction < 200 micro m of seven sediments originating from Lake Constance and the Neckar River were eluted up to eleven times at pH-values of 6, 7,5 and 9 using NTA-concentrations of 0, 0.3, 1, 3 and 10 mg/l H3NTA. The concentrations of 17 elements were determined by ICP/AES-spectrometry in all solutions. The elements examined do not behave the same in all sediments. This suggests that different species are present and that remobilization is a function of these. The slopes of the isotherms of remobilization, normalized to the specific amount of element contained in each sediment, show different behaviors, which give rise to the establishment of three groups of: 1) Elements which are not affected by NTA under the experimental conditions involved. These are aluminum, calcium, chromium, lithium and magnesium. 2) Elements which are slightly affected by NTA. These are manganese, lead and iron. Phosphorus is indirectly solubilized. In one sediment potassium and barium were slightly and presumably indirectly influenced by NTA. 3) Elements which are strongly remobilized by NTA. This group consists of nickel (at all pH-values), copper and cobalt (preferentially at pH 7.5, the least at pH 9), zinc (strongly affected at pH 7.5) and cadmium (strongly remobilized at pH 7.5, to a lesser extent at pH 9, not at pH 6). (Author's abstract)
W85-05043

LEGIONELLA ANISA: A NEW SPECIES OF LEGIONELLA ISOLATED FROM POTABLE WATERS AND A COOLING TOWER,
Center for Infectious Diseases, Atlanta, GA. Div. of Bacterial Diseases.
G. W. Gorman, J. C. Feeley, A. Steigerwalt, P. H. Edelstein, and C. W. Moss.
Applied and Environmental Microbiology, Vol. 49, No. 2, p 305-309, February, 1985. 4 Tab, 24 Ref.

Descriptors: *Legionella, *Bacteria, *Drinking water, Public health, Bacterial physiology, Water pollution sources.

Between March 1980 and June 1981, five strains of Legionella-like organisms were isolated from water. Four were recovered from potable water collected from hospitals in Chicago, Ill., and Los Angeles, Calif., during outbreaks of nosocomial legionellosis. The fifth strain was isolated from water collected from an industrial cooling tower in Jamestown, N.Y. The strains exhibited biochemical reactions typical of Legionella species and were gram-negative motile rods which grew on buffered charcoal-yeast extract agar but not on blood agar, required cysteine, and were catalase positive, urease negative, nitrate negative, hippurate negative, and nonfermentative. All strains were positive for oxidase and beta-lactamase and produced a brown, diffusible pigment. Of the five strains, four exhibited blue-white autofluorescence under long-wavelength UV light. The fatty-acid composition and ubiquinone content of these strains were consistent with those of other Legionella species. Direct fluorescent-antibody examination of the five strains with conjugates to previously described Legionella species demonstrated no cross-reactions except with the conjugates to L. longbeachae serogroup 2 and L. bozemanii serogroup 2. Four strains gave a 4+ reaction to the L. longbeachae serogroup 2 conjugate and the fifth strain gave a 1+ reaction. Each of the five strains gave a 4+ reaction with conjugate to L. bozemanii serogroup 2. DNAs from the five strains were highly related (84 to 99%) and showed 5 to 57% relatedness to other Legionella species. These strains constitute a new species in the genus Legionella, and the name Legionella anisa sp. nov. is proposed. The type strain of L. anisa is WA-316-C3 (ATCC 35292). (Author's abstract)
W85-05046

INFLUENCE OF EASILY DEGRADABLE NATURALLY OCCURRING CARBON SUBSTRATES ON BIODEGRADATION OF MONOSUBSTITUTED PHENOLS BY AQUATIC BACTERIA,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
R. J. Shimp, and F. K. Pfaender.
Applied and Environmental Microbiology, Vol. 49, No. 2, February, 1985. 4 Fig, 6 Tab, 29 Ref.

Descriptors: *Biodegradation, *Phenols, *Bacteria, *Fate of pollutants, Cresol, Aminophenol, Clorophenol, Napthalene.

The influence of readily degradable, naturally occurring carbon substrates on the biodegradation of several monosubstituted phenols (m-cresol, m-aminophenol, p-chlorophenol) was examined. The natural substrate classes used were amino acids, carbohydrates, and fatty acids. Samples of the microbial community from Lake Michie, a mesotrophic reservoir, were adapted to different levels of representatives from each natural substrate class in chemostats. After an extended adaptation period, the ability of the microbial community to degrade the monosubstituted phenols was determined by using a radiolabeled substrate uptake and mineralization method. Several microbiological characteristics of the communities were also measured. Adaptation to increasing concentrations of amino acids, carbohydrates, or fatty acids enhanced the ability of the microbial community to degrade all three phenols. The stimulation was largest for m-cresol and m-aminophenol. The mechanism responsible for the enhancement of monosubstituted phenol metabolism was not clearly identified, but the observation that adaptation to amino acids also increased the biodegradation of glucose and, to a lesser extent, naphthalene suggests a general stimulation of microbial metabolism. This study demonstrates that prior exposure to labile, natural substrates can significantly enhance the ability of aquatic microbial communities to respond to xenobiotics. (Author's abstract)
W85-05050

INFLUENCE OF NATURALLY OCCURRING HUMIC ACIDS ON BIODEGRADATION OF MONOSUBSTITUTED PHENOLS BY AQUATIC BACTERIA,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
R. Shimp, and F. K. Pfaender.
Applied and Environmental Microbiology, Vol. 49, No. 2, p 402-407, February, 1985. 5 Fig, 1 Tab, 21 Ref.

Descriptors: *Phenols, *Bacteria, *Humic acids, *Biodegradation, Degradation, Fate of pollutants, Cresol, Aminophenol, Chlorophenol, North Carolina.

Samples of the microbial community from Lake Michie, a mesotrophic reservoir in central North Carolina, were adapted to various levels (100 to 1,000 micro g/liter) of natural humic acids in chemostats. The humic acids were extracted from water samples from Black Lake, a highly colored lake in the coastal plain of North Carolina. After adaptation, the microbial community was tested for its ability to degrade the monosubstituted phenols m-cresol, m-aminophenol, and p-chlorophenol. Adaptation to increasing levels of humic acids significantly reduced the ability of the microbial communities to degrade all three phenols. The decline in biodegradation was accompanied by a decrease in the number of specific compound degraders in the adapted communities. Short-term exposure of the community to increasing levels of

humic acids had no significant effect on the ability of the community to degrade m-cresol. Thus the suppressive effect of humic acids, on monosubstituted phenol metabolism was the result of long-term exposure to the humic materials. Increasing the levels of inorganic nutrients fed to the chemostats during the humic acid adaptation had little effect on the suppressive influence of the humic acids, indicating that nutrient limitation was probably not responsible for the metabolic suppression. The results of the study suggest that long-term exposure to humic acids can reduce the ability of microbial communities to respond to monosubstituted phenols. (Author's abstract)
W85-05051

TRACE METALS IN THE COLUMBIA RIVER ESTUARY FOLLOWING THE 18 MAY 1980 ERUPTION OF MOUNT ST. HELENS,
Oregon State Univ., Corvallis. School of Oceanography.
G. F. Riedel, S. L. Wilson, and R. L. Holton.
Pacific Science, Vol. 38, No. 4, p 340-349, October, 1984. 4 Fig, 5 Tab, 26 Ref.

Descriptors: *Columbia River Estuary, *Estuaries, *Mount St. Helens, *Trace metals, Water pollution sources, Path of pollutants, Copper, Iron, Manganese, Nickel, Lead, Zinc, Metals.

Dissolved and suspended concentrations of cadmium, copper, iron, manganese, nickel, lead, and zinc were measured in the Columbia River Estuary following the 18 May 1980 eruption of Mount St. Helens. Soluble concentrations of these trace elements were not substantially elevated by the influx of volcanic ash and mud into the estuary during this period, except for somewhat higher than usual concentrations of manganese and copper. A laboratory experiment indicates that manganese leached from volcanic debris in fresh water and in the transition from fresh to slightly saline water probably caused the elevated Mn concentrations. Copper in solution may also have been enhanced slightly by leaching from the material into fresh water. (Author's abstract)
W85-05056

ACIDITY PROBLEMS CAUSED BY FLOOD CONTROL WORKS OF THE RIVER KYRONJOKI,
E. Alasaarela.
Vesientutkimuslaitoksen Julkaisuja, Vol. 49, p 3-16, 1982. 10 Fig, 2 Tab, 21 Ref.

Descriptors: *Sulfates, *Acidity, *Flood control, *Environmental impact, *Kyronjoki River, *Finland, Regulated flow, Path of pollutants.

Sulfates leaching from the bed of the former Litorina Sea have resulted in acidity problems in the river Kyronjoki (Finland). Calculations based on the change in sulfate concentration of the river water indicated that the waters draining from the Litorina basin contain 40-60 times the amount of sulfate contained in the waters of the higher reaches of the river. The acidity of the river water correlated highly significantly with the degree of dilution of the sulfate runoff. The correlation of acidity with the amount of sulfates in the waters draining form the Litorina basin was considerably weaker. The sulfate concentration in these waters is so high that the increased leaching caused by, e.g., drainage projects does not correspondingly increase the acidity problems. Considerably more important is the proportion in which the high-sulfate concentration waters are mixed with the mainstream flow. The periodical pumping of high-sulfate waters in conjunction with planned embankment works may cause harmful acid waves in the river Kyronjoki. Such situations could be prevented by suitable flow regulation. (Author's abstract)
W85-05060

TESTING THE APPLICABILITY OF THE CREAMS MODEL TO ESTIMATION OF AGRICULTURAL NUTRIENT LOSSES IN FINLAND,
For primary bibliographic entry see Field 2E.
W85-05062

IDENTIFICATION OF CRITICAL AREAS ON FOREST LANDS FOR CONTROL OF NON-POINT SOURCES OF POLLUTION,
East-West Environment and Policy Inst., Honolulu, HI.
For primary bibliographic entry see Field 2J.
W85-05068

PROSPECTS OF ACID RAIN OVER INDIA,
Meteorological Office, Poona (India).
K. Nand.
Mausam, Vol, 35, No. 2, p 225-232, April, 1984. 3 Fig, 3 Tab, 22 Ref.

Descriptors: *Acid rain, *India, *Acid deposition, *Hydrogen ion concentration, *Bombay, *Agra, Air pollution, Sulfur dioxide, Spatial distribution, Source of pollutants, Chemistry of precipitation.

Rainfall pH data of monthly samples collected from 10 Background Air Pollution Monitoring Network stations in India along with the other published data regarding precipitation chemistry and air pollution from different parts of India, as well as from other parts of the world, have been studied for assessing the prospects of acid rain over India. Rainfall pH values over unpolluted areas in India may be between 6 and 7 and lowering of pH to acidic values (less than 5.6) might be restricted to areas close to highly industrialized cities only, such as Bombay (pH 4.5); the phenomenon of acid rain may not be of regional nature. The main reason for the above is acid-base neutralization reactions in the presence of basic particulate matter. Due to high levels of suspended particulate matter over Agra, of which a good fraction is expected to be of a coarse mode, pH of rainwater over Agra is not expected to be in the acidic range. It may also not change to acidic values after the commissioning of Mathura Refinery, since the expected increase in concentration of gaseous pollutants at Agra (especially SO2) is not large. (Collier-IVI)
W85-05100

CHEMICAL COMPOSITION OF RAIN WATER WITH SPECIAL REFERENCE TO HEAVY METALS OVER LUCKNOW, UTTAR PRADESH IN 1981,
Central Ground Water Board, Lucknow (India). Central Chemical Lab.
For primary bibliographic entry see Field 2K.
W85-05101

DOSE EQUIVALENT COMMITMENTS FROM FALLOUT RADIONUCLIDES IN THE OPEN WATERS OF THE GREAT LAKES, 1973-1981,
Canada Centre for Inland Waters, Burlington (Ontario).
R. W. Durham, and S. R. Joshi.
Environmental Monitoring and Assessment, Vol. 4, No. 4, p 405-417, December, 1984. 2 Fig, 3 Tab, 18 Ref.

Descriptors: *Great Lakes, *Radionuclides, *Fallout, *Precipitation, Radioactivity, Radioactive wastes, Water quality, Lakes, Nuclear powerplants, Strontium radioisotopes, Cesium radioisotopes, Cerium radioisotopes, Antimony radioisotopes.

The water quality of the Great Lakes with respect to radioactivity is of concern since it is one source of the radiation dose received by the population of the Great Lakes Basin. The major contribution to radioactivity levels of the lake waters has come from fallout resulting from nuclear weapons testing in the atmosphere. The emergence of a nuclear power generation industry along the Great Lakes shoreline during the last two decades has created a potential problem from radioactive contamination. Aqueous wastes from this industry are discharged directly to the Great Lakes with the cooling water while some radionuclides discharged to the atmosphere are carried to the lake through precipitation scavenging. The levels of Ce-144, Cs-137, Sb-125, and Sr-90 were found to be very low over the period 1973 through 1981. Only up to 1975 was any Ce-144 detected, after which it dropped below the detection limit. Concentrations of the other three radionuclides decreased with time. Sr-90 and Cs-137 provide essentially all of the radiological dose from drinking Great Lakes water. The doses equivalent committments have been calculated from these measurements and found to be well within the Great Lakes Water Quality Agreement's water quality objective for radioactivity. (Baker-IVI)
W85-05103

PERSISTENCE AND FATE OF POLYNUCLEAR AROMATIC HYDROCARBONS DEPOSITED ON SLASH BURN SITES IN THE CASCADE MOUNTAINS AND COAST RANGE OF OREGON,
Oregon State Univ., Corvallis. Dept. of General Science.
T. J. Sullivan, and M. C. Mix.
Archives of Environmental Contamination and Toxicology, Vol. 14, No. 2, p 187-192, March, 1985. 2 Fig, 7 Tab, 22 Ref.

Descriptors: *Persistence, *Fate of pollutants, *Polynuclear aromatic hydrocarbons, *Slash burn, *Coast Range, *Cascade Mountains, *Oregon, Litter, Hydrocarbons, Aromatic compounds, Stream pollution.

Polynuclear aromatic hydrocarbons (PNAH) comprise a diverse group of nonpolar, lipophilic compounds produced during incomplete combustion processes. PNAH persistence over time on slash burn areas and the movement of these chemicals from charred litter into soil and an adjacent stream were investigated at sites in the Cascade Mountains and the Coast Range of Oregon. Phenanthrene and fluoranthene were gradually lost from the litter, reaching concentrations below detection limits less than two years after burning. Higher molecular weight polynuclear aromatic hydrocarbons were more persistent in the litter, decreasing after five years to about 19-23% of initial deposition. Movement into the top 2 cm of soil profile was more pronounced for the lower molecular weight PNAH, but all compounds appeared to equilibrate between litter and soil on the basis of organic content within one year after burning. Differential persistence and fate of PNAH in slash burn sites is explained by physical chemical characteristics of the compounds, such as solubility, vapor pressure, and octanol-water partition coefficient. The 5-7 ring compounds exhibit greater sorption by soil and litter organic matter as reflected by their higher octanol/water partition coefficients. Evaporation loss and leaching are less significant due to lower vapor pressure and water solubility. (Baker-IVI)
W85-05109

NATIONAL PESTICIDES MONITORING PROGRAM: RESIDUES OF ORGANOCHLORINE CHEMICALS IN FRESHWATER FISH, 1980-1981,
Columbia National Fisheries Research Lab., MO.
C. J. Schmitt, J. L. Zajicek, and M. A. Ribick.
Archives of Environmental Contamination and Toxicology, Vol. 14, No. 2, p 225-260, March, 1985. 6 Fig, 10 Tab, 88 Ref.

Descriptors: *Organochlorine compounds, *Persistence, *Fish, *Pesticides, Monitoring, Mirex, Pentachloroanisole, Benzene hexachloride, Endrin, Heptachor, Heachlorobenzene, Dacthal, Methoxychlor, Water analysis.

Results for organochorine chemical residues in freshwater fish collected in 1980 and 1981 are presented and compared with earlier findings. Concentrations of some of the most persistent organochlorine compounds were lower in 1980-1981 than at any time since the early 1970s. Average concentrations of DDT, polychlorinated biphenyls, and dieldrin declined significantly from 1976-1977 to 1980-1981, especially at the sampling stations where concentrations were the highest. Toxaphene levels at some sites in the South and the Great Lakes also declined somewhat since 1978-79, probably as a consequence of this insecticide's rapidly falling popularity for use on cotton. Despite declining concentrations, residues of many persist-

ent pesticides were still high enough in 1980-1981 to constitute a threat to fish and wildlife, as recently documented episodes of wildlife mortality have demonstrated. (Baker-IVI)
W85-05111

DETAILED MODEL FOR THE MOBILITY OF ARSENIC IN LACUSTRINE SEDIMENTS BASED ON MEASUREMENTS IN LAKE OHAKURI,
Auckland Univ. (New Zealand). Dept. of Chemistry.
J. Aggett, and G. A. O'Brien.
Environmental Science and Technology, Vol. 19, No. 3, p 231-238, 1985. 13 Fig, 4 Tab, 15 Ref.

Descriptors: *Arsenic, *Fate of pollutants, *Lake Ohakuri, *New Zealand, *Lake sediments, Lakes, Sediments, Industrial wastes, Hydroelectric plants, Seasonal variation, Stratification, Geothermal resources.

Lake Ohakuri is one of eight hydroelectric lakes on the Waikato River, New Zealand. The river passes through several active geothermal areas, and effluents from geothermal sources in these areas contain significant amounts of arsenic, the most important single source being the Wairakei power station. The mobility of arsenic in sediments in Lake Ohakuri has been monitored between 1980 and 1982 and the release of arsenic to the overlying water related to seasonal changes in both lake water and sediment. Despite the presence of considerable amounts of organic matter in these sediments, the arsenic cycle appears to be dominated by inorganic chemical processes. Arsenic(III), reputedly the more toxic form of inorganic arsenic, is present in the interstitial water, but provided the surficial layer of the sediment remains oxic, it is largely contained in the sediment system through adsorption on hydroxyiron(III) species near the sediment surface. The extent to which both arsenic(V) and arsenic(III) enter the lake water is largely dependent on the length of the stratification period. Although the redox potential of the lake water and river system generally favors the formation of arsenic(V), the current lack of knowledge of the rate of oxidation of arsenic(III) in natural waters prevents a meaningful assessment of the fate of the arsenic(III) released to the lake. (Baker-IVI)
W85-05117

THERMODYNAMICS OF THE HYDROGEN PEROXIDE-WATER SYSTEM,
Texas Tech Univ., Lubbock. Dept. of Chemistry.
H. Hwang, and P. K. Dasgupta.
Environmental Science and Technology, Vol. 19, No. 3, p 225-258, March, 1985. 4 Fig, 29 Ref.

Descriptors: *Hydrogen peroxide, *Sulfuric acid, *Thermodynamics, *Henry's law, Chemical reactions, Chemistry of precipitation.

The gas-phase concentration of hydrogen peroxide and its Henry's law constant are of critical importance in estimating the concentration of H2O2 in the aqueous phase such as in cloud droplets. This information may be used to assess the importance of the H2O2-mediated conversion of dissolved S(IV) to H2SO4 in hydrometeors. Henry's law constant of hydrogen peroxide was measured over a wide concentration and temperature range. Equilibrium gas-phase concentrations of hydrogen peroxide in dilute solution (0.00015 - 0.15 M) were determined for the temperature range 276-303 K. Henry's law is obeyed through the entire concentration range, and Henry's law constant (K sub H) may be expressed as exp(7920/T (K) - 15.44). A novel method for generation of low concentrations of water-soluble gases such as hydrogen peroxide was developed which involves the passing of an air stream through a porous tube immersed in a solution of H2O2. (Collier-IVI)
W85-05118

EFFECTS OF DEICING SALTS ON WATER CHEMISTRY AND VEGETATION IN PINHOOK BOG, INDIANA DUNES NATIONAL LAKESHORE,
National Park Service, Omaha, NE. Midwest Region.
For primary bibliographic entry see Field 5C.
W85-05123

SENSITIVITY ANALYSIS APPLIED TO UNSATURATED FLOW MODELING OF A RETORTED OIL SHALE PILE,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 2F.
W85-05181

SHORT TERM AND LONG TERM EFFECTS ON GROUNDWATER BY WASTEWATER INFILTRATION IN SUBSOIL SYSTEM,
National Swedish Environment Protection Board, Solna. Research Dept.
For primary bibliographic entry see Field 5D.
W85-05216

OIL SPILLS: WHAT HAVE WE LEARNED,
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 5C.
W85-05223

LEACHABILITY OF BARIUM-RADIUM SULFATE SLUDGES,
Regina Univ. (Saskatchewan). Faculty of Engineering.
P. M. Huck, and B. Anderson.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 375-386. 3 Fig, 11 Tab, 9 Ref.

Descriptors: *Leaching, *Sludge, *Sulfates, Uranium, Milling, Barium, Radium.

In the milling of uranium ore, only a small amount of product called yellow cake is produced, while almost the entire mass of ore is transformed into a waste product called tailings. These tailings are typically conveyed in slurry form to an impoundment area where the solids settle. The initial phase of a research program designed to examine the leachability of 226Ra from barium-radium sulfate sludges is presented. Liquid/solid contact time was relatively unimportant over the range of 0.5-4 hr. Leaching likely occurred almost immediately following contact of sludge with the leachant. 226Ra in the sludge was stable in the presence of deionized water at liquid:solid ratios in the range 10:1 to 1000:1. There was a slight increase in leachate dissolved 226Ra activity levels per gram of sludge at higher liquid:solid ratios. Low and high values of leachant pH increased radium leaching, with solutions of low pH being the strongest leachants. The effect of pH was reduced by the observed buffering capacity of the sludge. Monovalent salt solutions proved to be strong leachants. The amount leached decreased as molarity increased over the range 0.001-0.1 M. Divalent cations all appeared to be relatively strong leachants for radium, with the BaCl2 solution providing the greatest amount of leaching observed in the study. Dissolved 226Ra activity levels in the leachate decreased as leachant molarity increased. Only monovalent salts gave radium leachate values greater than the hypothetical minimum expected from the sludge mother liquor.
W85-05261

MICROSYSTEM SEDIMENT-WATER SIMULATION STUDY FOR THE PROPOSED JORDANELLE RESERVOIR, HEBER CITY, UTAH,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
D. Craft.
Available from the National Technical Information Service, Springfield, VA 22161. Report REC-ERC-83-13. December 1983. 21 p, 6 Fig, 11 Tab, 6 Ref.

Descriptors. *Reservoir design, *Reservoir sites, *Reservoir linings, *Simulation analysis, Water quality, Anaerobic conditions, Trace metals, Mine wastes, Water analysis, Soil analysis, Trace elements, Limnology, Design criteria, Jordanelle Reservoir, Upper Colorado Region, Central Utah Project, Bonneville Unit, Provo River, Heber City, Utah, Keetley, Utah.

The technique of microsystem sediment-water simulation was used to predict water quality data for the proposed Jordanelle Reservoir, Heber City, Utah. Simulation microsystems were prepared for four sites located in the north arm of the reservoir basin including two sites located in an abandoned acid mine tailings pond. Data obtained from the tailings pond microsystems indicated that low pH water and high trace metal concentrations will exist in the north arm of the reservoir. These data suggested that some kind of membrane or compacted earth lining will be necessary to seal and contain the mine spoilage. Other sites in the reservoir basin exhibited normal water quality. Near the proposed dam, anaerobic conditions will develop rapidly due to high available concentrations of organic carbon, and the subsequent release of zinc, iron, and manganese may pose a water quality problem. In the north arm near Keetley, simulation data indicated that anaerobic conditions will not develop as quickly or be a severe as conditions expected near the dam. Overall, the availability of nitrogen and phosphorus forms in the Provo River and Jordanelle sediments indicated that possible problems with algal blooms may exist in the reservoir.
W85-05305

HERBICIDAL RESIDUES AND ENVIRONMENTAL EFFECTS FROM THE EXPERIMENTAL APPLICATION OF TWO 2,4-D FORMULATIONS TO CONTROL EURASIAN WATERMILFOIL,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
For primary bibliographic entry see Field 5C.
W85-05308

ATMOSPHERIC TRAJECTORY MODELS FOR DIAGNOSING THE SOURCES OF ACID PRECIPITATION,
Michigan Univ., Ann Arbor. Dept. of Atmospheric and Oceanic Science.
P. J. Samson, and M. J. Small.
In: Modeling of Total Acid Precipitation Impacts. 1984. p 1-24, 15 Fig, 5 Tab, 34 Ref.

Descriptors: *Model studies, *Acid rain, *Water pollution sources, *Air pollution, *Sulfur, *Fate of pollutants, *Path of pollutants, Sulfates, Prediction, Comparison studies, Hydrologic models, Simulation analysis, Mathematical studies.

The University of Michigan Atmospheric Contributions to Interregional Deposition (ACID) Model was applied to simulate concentrations of ambient S and wet S deposition for January and July of 1978 at several Sulfate Regional Experiment (SURE) sites to evaluated the validity of model predictions. In general, the model did a reasonable job of predicting ambient sulfates during January and July but underestimated sulfates for locations near major Midwestern source regions, and overestimated sulfates at locations further downwind. The model reproduced the general magnitude of precipitation-associated sulfate, but underestimated wet deposition at several points downwind of major source regions. The ACID model was also applied to several receptor locations in the eastern United States and Canada in 1978 to study source receptor relationships. The model estimated that, independent of emissions, the area of greatest potential for contribution to ambient sulfate was located in upstate New York. The estimated contribution field for S wet deposition illustrated the bias in precipitation-bearing winds from the southwest by diminishing the role for the Sudbury site and expanding the role for the Ohio River Basin.
W85-05314

EULERIAN MODELING OF THE TRANSPORT AND CHEMICAL PROCESSES AFFECTING LONG-RANGE TRANSPORT OF SULFUR DIOXIDE AND SULFATE,

Iowa Univ., Iowa City.
G. R. Carmichael, and L. K. Peters.
In: Modeling of Total Acid Precipitation Impacts, 1984. p 25-51, 18 Fig, 3 Tab, 31 Ref.

Descriptors: *Model studies, *Acid rain, *Water pollution sources, *Mathematical models, *Hydrologic models, *Simulation analysis, *Fate of pollutants, *Sulfur, *Sulfates, Topography, Temporal distribution, Spatial distribution, Mathematical equations, Air pollution.

A Eulerian combined transport/chemistry/removal model that describes regional distribution of SO2 and sulfate in the eastern United States is described. The grid model is based on the coupled three-dimensional advection-diffusion equation and incorporates chemical transformation, dry deposition, spatial variation of topography, and spatial and temporal variations of mixing layer heights, wind field, eddy diffusivities, deposition velocities, and temperature and water vapor concentration profiles. Simulation results consisting of 24-hr averaged SO2 and sulfate ground level concentrations contours, deposition contours, and diurnal SO2 and sulfate vertical and ground level profiles are discussed along with regional SO2 and sulfate balances. These results illustrate the models capability to simulate the interactions between emissions, transport, chemistry and removal.
W85-05315

NORWEGIAN MODELS FOR SURFACE CHEMISTRY: AN OVERVIEW,
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 2A.
W85-05317

MODELING IMPACTS OF ACID PRECIPITATION FOR NORTHEASTERN MINNESOTA,
Iowa Univ., Iowa City. Div. of Energy Engineering.
For primary bibliographic entry see Field 2K.
W85-05320

DEVELOPMENT AND CALIBRATION OF THE INTEGRATED LAKE-WATERSHED ACIDIFICATION STUDY MODEL,
Tetra Tech, Inc., Lafayette, CA.
For primary bibliographic entry see Field 2K.
W85-05321

HYDROLOGIC AND WATER QUALITY MODELS FOR AGRICULTURE AND FORESTRY.
Virginia Polytechnic Inst. and State Univ., Blacksburg.
For primary bibliographic entry see Field 2A.
W85-05338

ANSWERS MODEL,
For primary bibliographic entry see Field 2A.
W85-05342

FINITE ELEMENT STORM HYDROGRAPH MODEL,
For primary bibliographic entry see Field 2A.
W85-05343

SIMPLIFIED METHOD FOR APPROXIMATING SUBSURFACE TRAVEL TIMES FOR SOLUTES IN WATERSHEDS,
For primary bibliographic entry see Field 2A.
W85-05344

GUIDE TO THE SELECTION OF MATERIALS FOR MONITORING WELL WELL CONSTRUCTION AND GROUND-WATER SAMPLING,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 7B.
W85-05350

DISCHARGE OF SOLIDS FROM RHODE RIVER SUBWATERSHEDS,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
J. W. Pierce.
In: Environmental Data Summary for the Rhode River Ecosystem (1970-1978), Section A: Long Term Physical/Chemical Data, Part 1: Airshed and Watershed, 1982. p 344-423, 17 Tab, 21 Ref.

Descriptors: *Watersheds, *Maryland, *Suspended solids, *Organic matter, *Seasonal variations, *Annual distribution, Regression analysis, *Baseline studies, Minerals, Mathematical studies, Mathematical equations, Sediment transport, Land use, Agricultural watersheds, Forest watersheds, Discharge capacity.

Discharge measurements were conducted at 7 weirs of Rhode River Subwatersheds and aliquots of flow-integrated water samples were analyzed for concentrations of total particulate material, mineral solids, and organic solids. Concentrations of solids in the integrated samples ranged from a low of 0.8 mg/liter to 1806.7 mg/liter total material and 0.2 to 1528.9 mg/liter for mineral solids. The lowest measured concentration of total solids in the samples occurred most frequently in the winter months, followed by spring. These two seasons were also characterized by the least fluctuations in flow rates. The average concentration of the samples was highest in the summer at all weirs and lowest in the summer. The lowest average concentration of organic matter occurred in the spring or winter. The concentration of solids did not appear to be affected by land use patterns. The greatest average weekly measured discharge of particulate material occurred in the summer, spring or winter, but never in the fall. Overall, there was very little difference between the 7 weirs in the ratio of mineral matter to organic solids. Regression analysis was used to predict missing values for particulate discharge. These data can be used to characterize non-point discharge by land use such that, given a mix of land uses in a watershed, seasonal or annual predictions could be made on the discharge of materials to receiving waters.
W85-05360

SEASONAL AND ANNUAL VARIATION IN NUTRIENT DISCHARGE FROM RHODE RIVER WATERSHEDS AND CERTAIN STREAM WATER QUALITY PARAMETERS,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
D. L. Correll.
In: Environmental Data Summary for the Rhode River Ecosystem (1970-1978), Section A: Long Term Physical/Chemical Data, Part 1: Airshed and Watershed, 1982. p 424-502, 1 Fig, 35 Tab, 14 Ref.

Descriptors: *Watersheds, *Maryland, *Nutrients, Discharge measurement, Nitrogen, Phosphorus, *Seasonal variation, Turbidity, *Annual distribution, Nitrogen compounds, Iron, Hydrologic data collections, Nitrate, Ammonia, Organic carbon, Phosphates, Data collections, Silica.

Twelve basins of the Rhode River watershed were analyzed for nutrient discharge (N, P, Ca, Mg, Si, Fe), pH, water temperature, turbidity, and inorganic C to study seasonal and annual variations. Mean annual discharge of P from basin-sized watersheds was 633 g/ha. No consistent seasonal pattern of P concentration or discharge was noted. N area yield discharges from basin-sized watersheds averaged 2,200 g/ha/yr. N area yields also showed no consistent seasonal pattern from one year to the next. The mean N/P ratio was highest in the winter, followed by spring and lowest in the summer. The mean annual energy content of organic matter in discharge water was 65.1 g-cal/liter. Concentrations of nitrate are highest in the winter and lowest in the fall while dissolved ammonia and organic N concentrations are highest in the summer. In all seasons orthophosphate-P constituted over half of the total P in an average year and well over half of this was bound to particulates. Dissolved orthophosphate levels were least in winter and increased steadily through the year till fall. Concentrations of reactive Si in spot tests from five basins were highest in summer. Mean dissolved Fe concentrations were higher in the fall. The mean pH of runoff for winter and spring seasons shows a general decrease from 1972 through 1978. Turbidity and temperature of streams vary among basins.
W85-05361

SEASONAL AND ANNUAL VARIATION IN THE DISCHARGE OF METALLIC CATIONS FROM RHODE RIVER WATERSHEDS,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
T. L. Wu, and H. E. Remenapp.
In: Environmental Data Summary for the Rhode River Ecosystem (1970-1978), Section A: Long Term Physical/Chemical Data, Part 1: Airshed and Watershed, 1982. p 503-600, 3 Fig, 4 Tab, 2 Ref.

Descriptors: *Heavy metals, *Maryland, *Metals, Discharge measurements, *Watersheds, *Cations, *Seasonal variation, *Hydrologic data collections, *Annual distribution, Land use, Rhode River, Baseline studies, Data collections.

Seasonal and annual variation of the discharge of metallic cations from eight mixed land use basin-sized Rhode River watersheds were determined by the measurement of the acid leachable metal content. Data are presented for discharge levels of Cu, Zn, Cr, Cd, Pb, Mn, Fe, Ca, Mg, Na, and K from each of the eight watersheds and area-yield discharge data are also given. In general, streamflow for all watersheds is highest in winter and lowest in summer. During 1975 which was a very wet year, summer area-yield discharges of Fe, Zn, and Cd were above their means, while Mn, Mg, and Ca were below. The extreme variability in concentration and discharge of metals is seen in data from watershed 101. Water discharge varied from 0 to 8 cm/month while flow weighted mean levels of Zn in discharge varied 300-fold. Mean discharges values of metals ranged three orders of magnitude and declined in the order of Na, Ca, K, Fe, Mg, Mn, Zn, Cr, Pb, Cu, and Cd.
W85-05362

RED HILL DISPOSAL SITE: A CASE STUDY,
Brown, Vence and Associates, San Francisco, CA.
For primary bibliographic entry see Field 5E.
W85-05368

INVESTIGATIONS OF LEACHATE CONTAMINATION OF GROUND AND SURFACE WATERS AT THE FRESH KILLS LANDFILL, NEW YORK CITY,
L. M. Page, S. J. Raila, and N. R. Woliner.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 175-209, 11 Fig, 1 Tab, 2 Append.

Descriptors: *Landfills, *Path of pollutants, *Fate of pollutants, *Groundwater pollution, *Leaching, *Tidal marshes, *Water pollution sources, *Geohydrology, Leachates, Chlorine, Conductivity, Salt marshes, Saline water intrusion, Salinity, Tidal currents, Wetlands, Tide lands, Monitoring, Aquifers, Tidal rivers, Surface water, Surface-groundwater relations, Garbage dumps, Waste dumps, New York.

The method and results used to determine the nature of groundwater and surface water contamination at the Fresh Kills landfill, Staten Island, New York as one part of the work necessary to satisfy Part 360 of the State Environmental Conservation Law and obtain a permit to continue operation are described. A hydrogeologic investigation showed saltwater intrusion of the glacial, Cretaceous Age and bedrock aquifers along the Arthur Kill and other tidal streams. In the south-central portion of Fresh Kills, the glacial and Cretaceous Age deposits have been contaminated by saltwater from tidal waters. The huge quantity of tidal flush overwhelms the estimated leachate flow so that little, if any effects of the landfill leachate can be seen at present. The chloride content of the groundwater was found to be abnormally high in

the garbage areas where monitor wells were installed. This was attributed to the residual high chlorine content of the tidal wetlands in which the garbage was placed which in turn was caused by saltwater intrusion. High conductivity contours were directly related to Arthur Kill and the tidal streams and the associated saltwater intrusions. Further studies are in progress to evaluate the directions, rates and volumes of contaminant flow from the landfill.
W85-05369

IMPACT OF SEWERAGE IRRIGATION ON THE CHEMISTRY OF GROUND AND SURFACE WATERS,
Kentucky Geological Survey, Lexington.
For primary bibliographic entry see Field 5E.
W85-05378

GEOHYDROLOGIC MODELLING FOR INDUSTRIAL WASTE DISPOSAL SITE EVALUATION,
Golder Associates, Atlanta, GA.
J. E. Baker, and A. Brown.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 380-392, 5 Fig, 3 Ref.

Descriptors: *Waste disposal, *Model studies, *Site selection, *Design criteria, *Mathematical models, *Hydrology models, *Path of pollutants, Groundwater movement, Land disposal, Fate of pollutants, Simulation analysis, Groundwater pollution, Models, Industrial wastes.

The Discrete Particle Random Walk (DPRW) model is presented as a suitable groundwater flow and solute transport model to aid in the selection and design of alternative waste disposal facilities. The model consists of a data entry and problem set-up component, a groundwater flow solution, a solute transport component, and output of results. The DPRW algorithm avoids problems encountered by direct solution of equations governing advection and dispersion processes. The model directly simulates the movement of the discrete particle in a porous media over discrete timesteps. To apply the DPRW model, certain geohydrologic and hydraulic data must be known, the solute transport portion of the model must be calibrated and a time history of both the quantity of seepage from the waste disposal facility and the geochemical make-up of the seepage through the operation and well into the reclamation of the facility must be known. The DPRW allows complex hydrogeologic settings to be studied. The transient nature of operation and reclamation of the waste disposal facility can be considered and the number of simplifying assumptions required is reduced. However, use of the model may require more input data, a higher degree of expertise, and more complicated verification methods.
W85-05379

FIELD INVESTIGATION OF A SUPERFUND SITE,
Residuals Management Technology, Inc., Madison, WI.
For primary bibliographic entry see Field 5E.
W85-05380

NATURAL BUFFERS FOR SLUDGE LEACHATE STABILIZATION,
Dames and Moore, Bethesda, MD.
For primary bibliographic entry see Field 5E.
W85-05383

WATER QUALITY EFFECTS AND GROWTH BENEFITS OF ENTRENCHING SEWAGE SLUDGE IN SANDY FOREST SOILS,
North Central Forest Experiment Station, East Lansing, MI.
For primary bibliographic entry see Field 5E.
W85-05384

ASSESSMENT OF THE RESIDUAL EFFECTS OF LONG-TERM SPRAY DISPOSAL OF AN INDUSTRIAL SLUDGE,
Tennessee Univ., Knoxville.
For primary bibliographic entry see Field 5E.
W85-05394

GENERAL STOCHASTIC MODEL FOR PREDICTING BOD AND DO IN STREAMS,
North Carolina Univ. at Charlotte. Dept. of Mathematics.
S. D. Damaskos, and A. S. Papadopoulos.
International Journal of Environmental Studies, Vol. 21, No. 3/4, p 229-237, October, 1983. 6 Fig, 10 Ref.

Descriptors: *Model studies, *Stochastic process, *Biochemical oxygen demand, *Dissolved oxygen, Differential equations, Path of pollutants, Prediction, Statistical studies.

Recent work on stochastic models for dissolved oxygen (DO) and biochemical oxygen demand (BOD) is extended in a more stochastic and therefore more realistic point of view. It is assumed that there are five major activities on the stream: the pollution and dissolved oxygen are decreased by bacterial action; the DO is increased due to process of reaeration at a rate proportional to the DO deficit; the BOD is only decreased by sedimentation and absorption at a rate proportional to the amount of pollution present with proportionally constant k3, in units of DO per day; the pollution is increased from small sources along the stretches of stream with rate la in ppm per day which is independent of the amount of pollution present; and the DO is decreased at a rate d-beta in ppm der day. Stochastic models are presented in terms of random differential equations and the solution processes are discussed. An example with computations is provided to illustrate the use of the model to determine the statistical properties of the BOD and DO processes at any point down the stream. (Baker-IVI)
W85-05443

COMPARISON OF SEASONAL AND DIURNAL PATTERNS OF SOME PHYSICO-CHEMICAL PARAMETERS OF THE OPEN AND CLOSED PARTS OF LOKTAK LAKE, MANIPUR, INDIA,
Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences.
For primary bibliographic entry see Field 2H.
W85-05444

FLUORIDE CONCENTRATION IN THE WATER OF THE RIVER CAUVERY, KARNATAKA, INDIA,
Mysore Univ. (India). Dept. of Botany.
R. K. Somashekar, and S. N. Ramaswamy.
International Journal of Environmental Studies, Vol. 21, No. 3/4, p 325-327, October, 1983. 1 Fig, 1 Tab, 7 Ref.

Descriptors: *Fluoride, *River Cauvery, *Karnataka, *India, Water pollution, Public health, Birds, Wildlife, Fish, Health hazard, Industrial wastes, Pulp and paper industry, Agricultural chemicals, Fertilizers.

A two year study was conducted concerning fluoride levels in the waters of river Cauvery near Mysore, Karnataka, India. Cauvery is an important river with a total length of 1500 km. Water from this river is used for domestic and industrial purposes all along its course. Fluoride concentrations were measured at five sampling points streching over 25 km. Sampling station 3 receives large amounts of effluents from fertilizer and paper factories. The effluents of a fertilizer factory have an average fluoride concentation of 300 mg/l. The fluoride levels at stations 3 and 4 exceed the value stipulated by WHO. Station 4 is near a bird sanctuary and the higher levels of fluoride in water at this point have threatened the bird life. Health hazards thus exist in the area and it is concluded that the water of the river Cauvery is not suitable for domestic use at stations 3 and 4. (Baker-IVI)
W85-05448

INFLUENCE OF REDOX POTENTIAL AND PH ON THE HEAVY METAL CONTENT OF GROUND WATER IN THE HEISINGER AUE AREA, WEST GERMANY (DER EINFLUSS VON REDOXPOTENTIAL UND PH AUF DIE SCHWERMETALLGEHALTE DES GRUNDWASSERS DER HEISINGER AUE (RUHRTAL SUDLICH ESSEN),
Essen Univ. (Gesamthochschule) (Germany, F.R.).Fachbereich 9 - Geologie.
P. Neumann-Mahlkau.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 18, No. 1, p 1-5, February, 1985. 11 Fig, 15 Ref.

Descriptors: *Heavy metals, *Groundwater pollution, *Heisinger Aue, *Germany (Federal Republic), Redox potential, Hydrogen ion concentration, Zinc, Cadmium, Copper, Lead, Iron, Arsenic.

In the Heisinger Aue area south of Essen (West Germany) the soil is contaminated with heavy metals from industrial water pollution. Different soil horizons are exposed to the ground water, because the ground water level is fluctuating depending on meteorological conditions. Analysis of the ground water from test pits yielded differing values of Zn, Cd, Cu, Pb, Fe and As. Exact observations of the soil profiles and measurement of Eh and pH show that there is a relation between Eh and the content of heavy metals in ground water. (Author's abstract)
W85-05450

EUTROPHICATION AND THE BALTIC SEA: CAUSES AND CONSEQUENCES,
Stockholm Univ. (Sweden). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W85-05464

DUAL FORMULATION OF FLOW FOR CONTAMINANT TRANSPORT MODELING; 1. REVIEW OF THEORY AND ACCURACY ASPECTS,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
E. O. Fring, and G. B. Matanga.
Water Resources Research, Vol. 21, No. 2, p 159-169, February, 1985. 15 Fig, 18 Ref.

Descriptors: *Path of pollutants, *Groundwater flow, *Groundwater pollution, Solute transport, Model studies, Fate of pollutants, Mathematical models.

The dual formulation for flow can offer significant advantages in the context of contaminant transport studies, compared with the conventional approach based on potentials only. The stream function solution provides directly the flow paths that control advective transport. These flow paths facilitate the direct visual positioning of contaminant plumes within a flow domain. The advective advance of a contaminant can be determined easily on the basis of the stream function plot. Because the governing equations are of the same form, one numerical model can produce both potentials and stream functions. Flow nets can be produced directly without the need for graphical construction. The stream function solution yields accurate boundary fluxes directly. These are important in connection with seepage from/to lakes and rivers. The method provides a means to verify the accuracy of the calculated velocity field, which is vulnerable to breakdown whenever the water table gradient approaches zero. The dual flow model can thus play a role in maintaining accuracy in transport simulations. The dual formulation applies only where flow transients are negligible and where the transport process is linear. (Baker-IVI)
W85-05496

DUAL FORMULATION OF FLOW FOR CONTAMINANT TRANSPORT MODELING; 2. THE BORDEN AQUIFER,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
E. 0. Frind, G. B. Matanga, and J. A. Cherry.
Water Resources Research, Vol. 21, No. 2, p 170-182, February, 1985. 17 Fig, 11 Ref. Natural Sci-

ences and Engineering Research Council of Canada grant A8368.

Descriptors: *Path of pollutants, *Model studies, *Borden Aquifer, *Ontario, Groundwater pollution, Groundwater flow, Simulation, Landfills, Solute transport, Velocity.

The validity and usefulness of the flow patterns simulated on the basis of short-term hydraulic head data are assessed. The contaminant plume considered occurs in an unconfined sand aquifer at an abandoned landfill on the Canadian Forces Base at Borden, Ontario. The landfill began operation as a refuse dump in 1940 and rapidly expanded during the war years. It was closed and covered with a thin layer of local sand in 1976. The Borden case study illustrates that for certain systems the long-term average flow regime that is needed for the assessment of contaminant migration cannot be obtained from field measurements of hydraulic head alone. Rather, it should be deduced by utilizing information that is representative of the long term. The information sought should include detailed stratigraphic data, measurements of permeability that are independent of field water level data, and the available recharge. Simulation should be used to investigate relevant combinations of the parameters and identify those that lead to extreme conditions of aquifer contamination. The Borden case suggests the possible existence of a weak link in some state of the art flow transport modeling procedures due to the fact that such procedures often consist of an operational sequence involving the calculation of hydraulic heads, the differentiation to obtain velocities, and the calculation of transport components based on those velocities. Clearly errors or irregularities in the velocities will be passed on to the transport procedure unless intercepted by manual inspection. The result will be a not unreasonable-looking, but still incorrect, simulated plume. The dual approach to flow modeling thus provides a useful basis for contaminant transport studies, both in the evalution of the hydrogeologic parameters relevant in the context of the transport problem and in the screening out of errors in the simulated flow field. (Baker-IVI)
W85-05497

MULTISOLUTE MASS TRANSPORT WITH CHEMICAL INTERACTION KINETICS,
Notre Dame Univ., IN. Dept. of Civil Engineering.
D. J. Kirkner, A. A. Jennings, and T. L. Theis.
Journal of Hydrology, Vol. 76, No. 1/2, p 107-117, January, 1985. 4 Fig, 17 Ref. DOE grant DE-AC-0279EV10253.

Descriptors: *Mass transport, *Convection, *Dispersion, *Kinetics, Chemical reactions, Groundwater management, Finite element method, Simulation, Solute transport, Algorithms.

A key aspect of the problem of protecting groundwater reserves is the ability to predict the migration of contaminants within the groundwater system. An algorithm is presented for multicomponent contaminant transport, which includes the effects of convection, dispersion, kinetic sorption reactions and equilibrium solution-phase reactions. The main feature of the algorithm is the modularization of the chemical calculations, thus allowing different chemical models to be studied quite easily. Comparisons of numerical simulations vs. analytical and experimental results are given. Current work includes the use of this algorithm to address the problem of the validity of the local equilibrium assumption. (Baker-IVI)
W85-05534

MOTION OF THE SEAWATER INTERFACE IN A COASTAL AQUIFER BY THE METHOD OF SUCCESSIVE STEADY STATES,
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
For primary bibliographic entry see Field 2F.
W85-05535

BREAKTHROUGH OF BRINE THROUGH COMPACTED FINE GRAINED SOILS,
Windsor Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W85-05571

PETROLEUM REFINERY STORMWATER RUN-OFF STUDY,
Standard Oil Co. (Ohio), Cleveland.
For primary bibliographic entry see Field 2A.
W85-05572

ECOLOGICAL MONITORING OF AQUEOUS EFFLUENTS FROM PETROLEUM REFINERIES,
CONCAWE, The Hague (Netherlands).
For primary bibliographic entry see Field 5A.
W85-05582

OIL AND DISPERSANTS IN CANADIAN SEAS: RESEARCH APPRAISAL AND RECOMMENDATIONS.
Environmental Protection Service, Ottawa (Ontario).
Available from Minister of Supply and Services Canada as En46-3/82-2E, EPS 3-EC-82-2, May 1982. Edited by J.B. Sprague, J.H. Vandermeulen, and P.G. Wells. 185 p, 574 Ref.

Descriptors: *Marine environment, *Environmental effects, *Oil spills, *Oil pollution, *Arctic, *Dispersants, *Fate of pollutants, *Water pollution effects, Ecological effects, Marine animals, Marine plants, Phytoplankton, Zooplankton, Microbial degradation, Literature review, Oil industry, Oil slicks, Cleanup operations.

This report appraises the fate and effects of petroleum spilled in Canadian marine environments, and the implication of using dispersants on spills in order to identify both knowledge and gaps in understanding the problems of oil pollution in northern waters. Twelve chapters by individual scientists give perspectives on the Canadian oil industry; fate and behavior of oil in the sea; microorganisms and degradation of oil; analytical chemistry; and effects of oil, dispersants, and chemically dispersed oil on phytoplankton, macrophytes, zooplankton, fish, benthic and intertidal organisms, birds, marine mammals, and communities, and ecosystems. General information gaps on dispersants and the fate and effects of oil in the Arctic exist. Further research is required to minimize the effects of spills. This implies that Canada should strengthen its capabilities for long-term studies of marine environments.
W85-05583

FATE AND BEHAVIOUR OF OIL SPILLS,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
D. Mackay.
In: Oil and Dispersants in Canadian Seas: Research Appraisal and Recommendations, EPS 3-EC-82-2, May 1982, Environmental Protection Service, Ottawa (Ontario). p 7-27, 2 Fig.

Descriptors: *Biodegradation, *Oil spills, *Fate of pollutants, *Dispersants, *Oil slicks, *Marine environment, *Cleanup operations, *Arctic, Microbial degradation, Oil pollution, Evaporation, Oxidation, Models.

The physical, chemical, and biological processes which occur at sea when oil is spilled are described. During the first day of the spill, evaporation and dispersion of oil particles into the water column take place. Evaporation proceeds until 25% of the spill may have evaporated in 2 to 5 days. Subsequent photolytic oxidation in the atmosphere is fairly rapid. As the spill spreads, an increasing fraction of oil is dispersed into the water column and the surface slick may disappear. The oil remaining on the surface eventually becomes tar lumps which may be stranded on beaches. Biodegradation is the most important oil removal process during the first year. Small amounts of oil sink to the bottom or are ingested by animals of various trophic levels. The spreading and drifting of oil slicks have been extensively modeled and are relatively predictable. However, little is known about dispersion of oil in the water column. The principal resistive effect to dispersion is the water-oil interfacial tension. Dissolved hydrocarbons under an oil slick may be of toxicological significance. The incorporation of oil into growing first-year ice and its subsequent release in the spring has been well documented. Burning of oil on ice has been tried but more research is required on its environmental effects. Oil spill modelling will involve the integration of many complex environmental processes.
W85-05584

MICROORGANISMS AND THE DEGRADATION OF OIL UNDER NORTHERN MARINE CONDITIONS,
Alberta Univ., Edmonton. Dept. of Microbiology.
D. W. Westlake.
In: Oil and Dispersants in Canadian Seas: Research Appraisal and Recommendations, EPS 3-EC-82-27. May 1982, Environmental Protection Service, Ottawa (Ontario). p 47-53.

Descriptors: *Microbial degradation, *Marine environments, *Biodegradation, *Oil pollution, *Dispersants, *Marine bacteria, *Hydrocarbons, *Fate of pollutants, Oil spills, *Microorganisms, Microbiological studies, Degradation, Water pollution effects, Arctic, Cleanup operations, Marine sediments.

The interactions of the various physical and chemical parameters which control the microbiological degradation of oil under northern marine environmental conditions are summarized. The types of oil degrading microorganisms present in an environment will be increased if oil is present at that site. Oil biodegradation studies have been enhanced by using a synthetic crude spiked with specifically labeled hydrocarbons which allows monitoring of the disappearance of individual or groups of compounds. Under the severe environmental conditions of northern marine waters, it is doubtful that oil-degrading microbes could play an important role in the clean-up of oil spills. Oil incorporated into anaerobic sub-tidal sediments will not undergo biodegradation, as the initial attack on hydrocarbon molecules by microorganisms requires oxygen. Factors affecting the utilization of oil by marine microorganisms include the availability of nutrients, temperatures and ice formation, and the toxic effects of dispersants. More data is needed on the distribution and activity of oil-degrading microorganisms and on the status of the controlling physicochemical parameters in northern marine ecosystems. Research on the toxicity of oil (and the oil plus dispersants) and its effect on the C/N ratio of the already stressed environment is recommended.
W85-05585

EFFECTS OF PETROLEUM HYDROCARBONS ON PHYTOPLANKTON AND MACROPHYTES,
Department of Indian Affairs and Northern Development, Ottawa (Ontario).
N. Snow.
In: Oil and Dispersants in Canadian Seas: Research Appraisal and Recommendations, EPS 3-EC-82-27, May 1982, Environmental Protection Service, Ottawa (Ontario). p 55-63.

Descriptors: *Oil pollution, *Water pollution effects, *Fate of pollutants, *Phytoplankton, *Macrophytes, *Oil, *Microbial degradation, *Phytotoxicity, Oil spills, Toxicity, Arctic, Marine environment, Hydrocarbons, Dispersants, Photosynthesis, Marine algae, Marine plants.

A range of phytoplankton responses exists to both oil fractions and whole oils with species-specific toxicities, depending on how the oils are introduced into the environment, on water temperature, and on other physiologic conditions. Low concentrations of hydrocarbons stimulate phytoplankton activity but depress photosynthesis and algal growth. The effects of oil on marine macrophytes follow a pattern similar to the effects on phytoplankton. If the phytotoxicity of crude oil or its components is mediated via cell membrane disrup-

tion, or if cellular metabolic substrates are being changed, then chemical dispersants could affect such a mode of action. Dispersants would accelerate the introduction of oil into the water column and the mixture might prove more toxic than oil alone. More work is needed on the effects of dispersed oil on marine plants under all conditions which dispersants might be used. It is recommended that the effects of oil and dispersed oil on epontic phytoplankton communities, and arctic and subarctic sublittoral macroalgae be studied at different seasons of the year. Further research is also needed on the effects of petroleum hydrocarbons on inter-conversion of biochemical cell constituents, the mechanisms of phytotoxicity, and the effects of differing sizes of oil droplets.
W85-05586

ANALYTICAL CHEMISTRY,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5A.
W85-05593

INFLUENCE OF DISPOSAL ENVIRONMENT ON AVAILABILITY AND PLANT UPTAKE OF HEAVY METALS IN DREDGED MATERIAL,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
B. L. Folsom, C. R. Lee, and D. J. Bates.
Technical Report EL-81-12, December 1981. Final Report. 159 p, 25 Fig, 52 Tab, 155 Ref, Append.

Descriptors: *Heavy metals, *Marsh plants, *Bioaccumulation, Cyperus esculentus, Spartina alterniflora, Distichtis spicata, Sediments, Contamination, Saline Water, Spoil banks, Dredging, Zinc, Cadium, Copper, Iron, Manganese, Arsenic, Mercury, Nickel, Chromium, Lead, Organic compounds, Nitrogen, Phosphorus, Sulfur, Grease, Hydrogen ion concentrations, Calcium carbonate.

Heavy metal uptake by Cyperus esculentus from 15 highly contaminated freshwater sediments under reduced (flooded) and oxidized (upland) disposal conditions was investigated in the greenhouse. Heavy metal uptake by Spartina alterniflora and Distichlis spicata from 14 highly contaminated saltwater sediment under flooded disposal conditions was also investigated. The sediments were transported to the laboratory where half was potted and maintained in a flooded state; the other half was air dried and ground before being potted (upland condition). Cyperus esculentus was grown from tubers planted in the freshwater sediments. Seeds of S. alterniflora and D. spicata were planted in the saltwater sediments. The plants were harvested and analyzed for the heavy metals Zn, Cd, Cu, Fe, Mn, As, Hg, Ni, Cr and Pb. The sediments were analyzed for total heavy metals, diethylene triamine pentaacetic acid (DTPA) extractable heavy metals, heavy metals in the sediment interstitial water, oil and grease, pH, calcium equivalent, total phosporus, total Kjeldahl nitrogen, and organic matter. Air drying the sediments resulted in increased DTPA extractable and interstitial water heavy metals. Plant uptake of heavy metals, especially Zn, and Cd, was greater in plants grown in upland sediments compared with flooded sediments. Plant yield was an important factor in determining plant uptake of heavy metals. Since the results of this investigation showed that plant uptake of heavy metals was site specific, it is recommended that a plant bioassay be performed on sediments to determine the availability of heavy metals contained in those sediments.
W85-05601

SUBMODELS FOR THE NUTRIENT LOADING ESTIMATION ON RIVER ZALA,
Magyar Tudomanyos Akademia, Budapest. Szamitastechnikai es Automatizalasi Kutato Intezete.
M. Bolla, and T. Kutas.
Ecological Modelling, Vol. 26, No. 1/2, p 115-143, December, 1984. 14 Fig, 8 Tab, 16 Ref.

Descriptors: *Nutrient loading, *River Zala, *Lake Balaton, *Hungary, Model studies, Estimating, Nutrients, Nitrogen, Phosphorus, Snowmelt, Simulation.

An important requirement of the Balaton Ecological Modelling approach to water-body modelling is to develop a nutrient loading estimation for Lake Balaton. For the Western Basin, estimates were made of the nutrient load from municipal sewage and of agricultural origin discharged by River Zala. The approaches used are described by different submodels: submodels which separate floodwaves from base-flow, regression submodels for the relationships between the discharge and different kinds of nutrient loadings, a submodel which separates the phosphorus and nitrogen of municipal sewage and those of agricultural origin and an erosion submodel. Any of the submodels can be dropped out or substituted by other submodels. The submodels are calibrated separately before they are merged. On the basis of these submodels a simulation was performed for the time interval 1976-79. The monthly and yearly averages of the simulated daily results were in good agreement with the existing measurements. Using this approach one can also take account of snowmelt. Knowing the number of snowy days, the average depth of snow-cover and other parameters characterizing a sub-watershed, the volume of melted snow can be calculated. The location of snowmelts should be done by another submodel influenced by meteorological factors such as air temperature. With this approach one can also take into consideration other phosphorus and nitrogen compounds. (Baker-IVI)
W85-05604

DISPERSION OF RADIOACTIVE POLLUTION IN SURFACE WATER,
Karlova Univ., Prague (Czecheslovakia). Dept. of Nuclear Physics.
I. Chytil.
Ecological Modelling, Vol. 26, No. 1/2, p 145-153, December, 1984. 16 Ref.

Descriptors: *Radioactive wastes, *Nuclear powerplants, *Dispersion, Path of pollutants, Surface waters, Mathematical equations.

A mathematical description of the dispersion of radioactive pollution in surface water is presented based on a discussion of the phenomena which influence it. A differential equation in the general form is obtained and simplified to give the most convenient solution for the investigation of radioactive doses during normal operation of a nuclear power plant. Specific activity of radionuclides is time-and space-dependent and is influenced by physical, chemical and biological phenomena each of which is different in significance and is variable depending on the character of the stream. The influence of each phenomenon is expressed by the transport equation or by the boundary conditions. Simplification of the transport equation and boundary conditions is considered. An example is provided in which the prediction of the distribution of the specific activity in the streams is determined which leads to the predictive calculation of radioactive doses from nuclear power plants. The results have been used to predict the radioactive doses from planned power plants. (Baker-IVI)
W85-05605

IMPACT OF HUMAN ACTIVITIES ON WATER QUALITY - A CASE STUDY OF WATER POLLUTION IN JAIPUR (INDIA),
Rajasthan Univ., Jaipur (India). Dept. of Botany.
B. Gopal, and P. K. Goel.
Limnologica (Berlin), Vol. 16, No. 1, p 39-43, September, 1984. 2 Fig, 1 Tab, 12 Ref.

Descriptors: *Water pollution sources, *Wastewater disposal, *Industrial effluent, *Jaipur, *India, Water pollution effects, Sanitation, Drinking water, Public health.

A brief report is offered on the sources of water pollution resulting from diverse human activities in India. Extreme contrasts exist between the rural and the urban areas. Industrial effluents are among the most important sources of water pollution next to the domestic wastes. Continued use of the same water for bathing, sewage disposal, drinking and all other purposes leads to frequent disease outbreaks and other problems. Water pollution around Jaipur, which lies in the semiarid region of the state of Rajasthan, is described. There are several small industries in the area and most of the wastes are dumped into the Amanishah drain passing through the township. In many cases effluents are disposed of on land. (Baker-IVI)
W85-05614

HEAVY METALS IN THE SEDIMENTS OF LLANGORSE LAKE, WALES SINCE CELTIC-ROMAN TIMES,
Trent Univ., Peterborough (Ontario). Dept. of Biology.
R. Jones.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1377-1382, December, 1984. 5 Fig, 19 Ref.

Descriptors: *Llangorse Lake, *Wales, *Heavy metals, *Eutrophic lakes, *Lake sediments, Sediments, Chemical analysis, Copper, Lead, Zinc, Titanium, Catchments, History, Soil erosion, Organic matter.

Llangorse Lake is a small, shallow, eutrophic lake situated in the lowlands of the eastern half of the Brecon Beacons National Park in south central Wales. An abrupt change in stratigraphy near the bases of the sediment cores was noted, caused by a substantial increase in soil erosion following expansion of forest clearing activity after the Welsh tribes had been subjugated by the Romans in the campaign of AD 74-78. Changes in the concentrations of titanium, copper, zinc and lead in the sediments caused by this major pertubation in the lake catchment and also concentrations of these metals in more recent sediments were examined. In the silty/clay above the transition zone, the concentration of Cu increases and then declines in all cores. These changes appear to be associated with an increase and then a decline in sediment organic matter. Even though the top few cm of sediment were not sampled, it is likely that Cu, Zn, and Pb are still accumulating as a result of atmospheric supply from anthropogenic sources, from agricultural sources and from recreational activity, as occurs in lakes in other areas. (Baker-IVI)
W85-05625

RIVER BURE, UNITED KINGDOM: PATTERNS OF CHANGE IN CHEMISTRY AND PHYTOPLANKTON IN A SLOW-FLOWING FERTILE RIVER,
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 2E.
W85-05676

SEDIMENTATION RATES AND HEAVY METAL POLLUTION OF SEDIMENTS IN THE SETO INLAND SEA, PART 3. HIUCHI-NADA,
Government Industrial Research Inst., Kyushu, Tosu (Japan).
A. Hoshika, and T. Shiozawa.
Journal of the Oceanographical Society of Japan, Vol. 40, No. 5, p 334-342, October, 1984. 5 Fig, 3 Tab, 8 Ref.

Descriptors: *Sedimentation rate, *Heavy metals, *Water pollution sources, *Hiuchi-Nada, *Japan, *Seto Inland Sea, Copper, Zinc, Lead radioisotopes, Industrial wastes.

In the Hiuchi-Nada area of the Seto Inland Sea, Japan, sedimentation rates were determined with the Pb-210 technique, and heavy metals in sediments were also analyzed. Sediments were collected in twelve short sediment cores and a long sediment core, using 1-m and 6-m gravity corers. The sedimentation rates vary from 0.14 to 0.31 g/sq cm/yr. The highest sedimentation rate was observed in the central part of the area, while lower sedimentation rates were observed in the eastern part. In Hiuchi-Nada, a remarkable increase in copper and zinc contents is noticeable as early as the 1800's. Over the past 240 years a copper smelter at a south-western side of this area has been causing serious pollution of the sediment. Now, anthropogenic copper and zinc loads into the sedi-

ment are 123 and 376 ton/yr compared to natural copper and zinc loads of 82 and 401 ton/yr, respectively. The highest level of copper and zinc pollution was observed in the 1960's, when the relative enrichments above background values (copper; 19 and zinc; 93 mg/kg) were 5.5 and 2.8, respectively. (Author's abstract)
W85-05687

PHOSPHORUS CYCLING IN IONICALLY POLLUTED ONONDAGA LAKE, NEW YORK,
Upstate Freshwater Inst., Inc., Syracuse, NY.
S. W. Effler, C. T. Driscoll, M. C. Wodka, R. Honstein, and S. P. Devan.
Water, Air, and Soil Pollution, Vol. 24, No. 2, p 121-130, February, 1985. 3 Fig, 44 Ref.

Descriptors: *Onondaga Lake, *New York, *Phosphorus, *Cycling nutrients, Lake restoration, Industrial wastes, Chlor-alkali industry, Fate of pollutants, Mixing, Chemical reactions, Lake sediments.

Onondaga Lake is a small lake located in metropolitan Syracuse, New York. It is considered one of the most polluted lakes in the northeast US, having received the domestic effluents and much of the industrial wastes from the metropolitan area for more than a century. A ten-fold reduction in P loading to the lake from 1970-1981 was achieved through implementation of reclamation measures that included a ban on P detergents and the addition of secondary and tertiary processes at the adjoining sewage treatment plant. The failure of Onondaga Lake to respond to major reductions in external P loading achieved by 1981 reflects the degree to which the system was originally overloaded. The ionic loading from a chlor-alkali manufacturer has altered the behavior of P in a least four ways: reduced vertical mixing; enhanced chemical reactivity of P; increased rate of deposition of P; and reduced availability of sedimentary P. These features reflect very nonconservative behavior of P in the lake, which should facilitate the positive response of the lake to further restoration efforts. Internal P cycling, and P concentrations, in the lake would increase if the loading of ionic material from the major source was discontinued, due to the reversal of existing pollution-based alterations of the P cycle. The available P in the productive layers of the lake would increase, reversing a trend toward nutrient-limitation that has been achieved at great cost. It could alter the phytoplankton assemblage of the lake, and increased the transport of P from the lake to Lake Ontario. (Moore-IVI)
W85-05690

LONG DISTANCE TRANSPORT OF ANTHROPOGENIC LEAD AS MEASURED BY LAKE SEDIMENTS,
Trent Univ., Peterborough (Ontario). Environmental and Resource Studies Program.
R. D. Evans, and F. H. Rigler.
Water, Air, and Soil Pollution, Vol. 24, No. 2, p 141-151, February, 1985. 4 Fig, 1 Tab, 28 Ref.

Descriptors: *Lead, *Lake sediments, *Atmospheric deposition, *Ontario, *Quebec, Heavy metals, Lead radioisotopes, Path of pollutants, Spatial distribution, Fallout.

Long-term atmospheric deposition of Pb has been measured using lake sediment cores. The average 'whole-lake' Pb burden was measured for several lakes in each of four regions located throughout Ontario and Quebec, Canada. Since the regions were remote to any point source of Pb, large scale variation in atmospheric transport could be studied. The results indicate that Pb deposition is highest in South-Central Ontario, where lake burdens ranged from 312 to 432 mg/sq m, and that it decreases in an eastward direction into Quebec. Lowest deposition was at the site farthest north, Schefferville, Quebec, where fallout was 31 to 42 mg/sq m, less than one-tenth of that previously observed in South-Central Ontario. Lead-210 dating of sediment cores from the northern site showed that input to these remote lakes has occurred over the same time period as in the southern sites. (Author's abstract)
W85-05691

SEASONAL VARIATIONS OF OIL RESIDUES IN WATER OF SHATT AL-ARAB RIVER, IRAQ,
Basrah Univ. (Iraq). Marine Science Centre.
A. A. Z. Douabul, and H. T. Al-Saad.
Water, Air, and Soil Pollution, Vol. 24, No. 3, p 237-246, March, 1985. 3 Fig, 5 Tab, 34 Ref.

Descriptors: *Shatt al-Arab River, *Iraq, *Oil pollution, *Seasonal variation, Water pollution sources, Fate of pollutants, Hydrocarbons, Distribution, Wastewater pollution, Urban runoff.

The Shatt al-Arab River is the most important river and the only source of fresh water in the arid surroundings of southern Iraq. Shatt al-Arab waters are liable to contain petroleum origin wastes because of the numerous oil operations. Five sampling sites were selected to represent different regions of the north section of Shatt al-Arab River. A reference stations was chosen at the Euphrates River. The distribution and seasonal variations of petroleum residues in the water column were determined spectrofluorometrically. Water samples collected from the reference station throughout the study period had no measurable amounts of petroleum hydrocarbons. The petroleum residue concentrations in the Shatt al-Arab River water column were found to vary between 1.7 to 35.4 micro-g/L Kuwait crude oil equivalents. The results suggested that petroleum hydrocarbons present in this river originated from diverse sources. Sewage discharge and urban runoff may be the most significant sources of oil entering the river. It is estimated that the river transports about 48 tons of petroleum hydrocarbons to the Arabian Gulf annually. Hydrocarbon amounts tend to be highest in winter (averaged 17.4 micro-g/L) and lowest in summer (averaged 3.1 micro-g/L). Processes brought about by temperature variations are postulated to produce the pronounced seasonal variation in petroleum residues, while variations in the water volume of the river seem to have limited effect in this respect. (Moore-IVI)
W85-05696

PERSISTENCE OF PHENOLS IN AQUATIC MICROCOSMS RECEIVING CHRONIC INPUTS OF COAL-DERIVED OIL,
Oak Ridge National Lab., TN. Environmental Sciences Div.
G. R. Southworth, S. E. Herbes, P. J. Franco, and J. M. Giddings.
Water, Air, and Soil Pollution, Vol. 24, No. 3, p 283-296, March, 1985. 7 Fig, 1 Tab, 18 Ref. DOE contract DE-AC05-840R21400.

Descriptors: *Phenols, *Oil pollution, *Coal-derived oil, Fate of pollutants, Oil spills, Microcosms, Microbial degradation, Alkylphenols.

The environmental fate of constituent phenols of a coal-derived oil spill intermittently on water was evaluated in aquatic microcosms. Phenols dissolved rapidly from the oil into the water, and initially accumulated with sequential oil additions. The major process removing phenols from the microcosms was microbial degradation - other processes were negligible in comparison. After phenols attained maximum concentrations in the first 28 days of the study, degradation rates exceeded input rates in all microcosms during the second 28 days the study and total phenol concentrations decreased. Significant differences were apparent in the rates of degradation of various alkylphenol isomers and isomer groups, but no compounds were observed to be refractory. Upon discontinuation of oil inputs at day 56, dissolved phenols disappeared within several weeks. Microcosm exposure history and the presence of other phenol isomers affected the rate of removal of individual isomers, complicating prediction of the rate of removal of individual toxicants. (Author's abstract)
W85-05700

SILVER AND OTHER METALS IN SOME AQUATIC BRYOPHYTES FROM STREAMS IN THE LEAD MINING DISTRICT OF MID-WALES, GREAT BRITAIN,
Chelsea Coll., London (England). Dept. of Biological Sciences.
K. C. Jones, P. J. Peterson, and B. E. Davies.
Water, Air, Soil Pollution, Vol. 24, No. 3, p 329-338, March, 1985. 2 Fig, 5 Tab, 22 Ref.

Descriptors: *Bryophytes, *Silver, *Heavy metals, *Wales, Mines, Monitoring, Bioindicators, Cadmium, Copper, Lead, Zinc, Surface waters.

It is probable that wherever Pb mining has caused Pb pollution Ag is also present as a contaminant. Surface waters and three aquatic bryophytes (Scapania undulata, Hygrohypnum luridum and Polytrichum commune) in the mid-Wales Ag-Pb mining district were sampled for trace metals. This area is contaminated by heavy metals from past mining. Elevated levels of Ag, Cd, Cu, Pb, and Zn were found in water and plant tissue. Aquatic bryophytes which have been reported to accumulate Pb and other toxic metals also accumulate Ag in the same environments. This ability to accumulate these metals is especially important for Ag in view of the analytical difficulties in determining the dissolved metal which is found only at the ng/L level even in polluted waters. All the plants accumulated Ag and the other metals but Scapania appears the most suitable as a plant monitor of Ag-polluted waters. It is widely available in streams and rivers and can be collected throughout the year. (Moore-IVI)
W85-05702

INFLUENCE OF NITRATE ON THE PHOSPHORUS FLUX TO AND FROM OXYGEN DEPLETED LAKE SEDIMENTS,
Uppsala Univ. (Sweden). Limnologiska Institutionen.
For primary bibliographic entry see Field 2K.
W85-05716

SEASONAL DISTRIBUTION OF ENTEROVIRUSES AND ADENOVIRUSES IN DOMESTIC SEWAGE,
Institut Pasteur Hellenique, Athens (Greece). Dept. of Virology.
V. Krikelis, N. Spyrou, P. Markoulatos, and C. Serie.
Canadian Journal of Microbiology, Vol. 31, No. 1, p 24-25, January, 1985. 1 Fig, 1 Tab, 11 Ref.

Descriptors: *Seasonal variation, *Viruses, *Wastewater, *Athens, *Greece, Domestic wastes, Adenoviruses, Enteroviruses, Effluents, Poliovirus, Coxsackievirus, Echovirus.

A seasonal distribution of enteroviruses and adenoviruses in raw sewage effluents of Athens, Greece, was observed over a 15-month surveillance period. All 36 samples tested were positive for both virus groups. Adenovirus concentration levels ranged from 70 to 3200 cytopathic units per liter of sample, whereas the corresponding values for enteroviruses were 90-900 cytopathic units per liter. Peak values for adenoviruses were recorded during the months of April and June 1983, whereas for enteroviruses the peak was recorded in September 1983. All three types of poliovirus were present. Coxsackievirus types B-1, B-2, B-4, and B-5 and echovirus type 7 were also isolated. Adenovirus types 1, 2, 3, 5, 7, and 15 were detected as well. (Author's abstract)
W85-05742

FLUX OF LEAD IN SUBMERGED PLANTS AND ITS RELEVANCE TO A FRESHWATER SYSTEM,
Westfield Coll., London (England). Dept. of Botany.
M. Everard, and P. Denny.
Aquatic Botany, Vol. 21, No. 2, p 181-193, February, 1985. 5 Fig, 2 Tab, 24 Ref.

Descriptors: *Lead, *Submerged plants, Path of pollutants, Algae, Macrophytes, Mosses, Heavy metals, Epiphytes, Lake sediments, Sorption, Turbulence.

The fluxes of lead in submerged freshwater angiosperms, mosses and benthic algae were investigated by laboratory and field observations. Laboratory experiments showed that the initial uptake of lead

by angiosperm shoots and Navicula sp. was rapid (up to 0.07 mg Pb/g dry weight/min from a solution containing 1.0 mg Pb/l), and overwhelmingly passive. Mosses were especially efficient at sorbing lead from solutions containing less than 1.0 mg Pb/l. Rates of uptake increased with rising external concentrations, but decreased with time. Anatomical and morphological characteristics of plant tissues affected metal flux and an epiphytic covering of Navicula (i.e., an Aufwuchs community) sorbed metal and reduced uptake into tissue by a third. Up to 90% of the lead sorbed in the first hour by shoots of Elodea canadensis Michx from a solution containing 1.0 mg Pb/l was released within 14 days of transfer into a lead-free medium; 10% was irreversibly bound. Moss monitors placed in Ullswater, a lake with sediments containing up to 26 mg Pb/g dry weight, confirmed that the metal is brought into circulation during turbulence, but not in periods of calm. Shoots of Elodea collected from the lake contained up to 0.3 mg/g dry weight non-exchangeable lead. Young shoots tended to contain less than older shoots (0.12 compared with 0.3 mg Pb/g), and leaf more than stem tissues. The fluxes of lead from the environment through Aufwuchs and submerged plants are discussed. (Author's abstract)
W85-05745

DISTRIBUTION AND ISOTOPIC COMPOSITION OF SULFUR IN LAKE SEDIMENTS OF NORTHERN ONTARIO,
National Water Research Inst., Burlington (Ontario).
J. O. Nriagu, and Y. K. Soon.
Geochimica et Cosmochimica Acta, Vol. 49, No. 3, p 823-834, March, 1985. 5 Fig, 8 Tab, 77 Ref.

Descriptors: *Lake sediments, *Sulfur, *Isotope studies, *Water pollution sources, *Ontario, Sulfides, Sulfates, Detritus, Diagenesis, Organic matter, Sediments.

Sediments from unpolluted and highly polluted lakes in northern Ontario have been fractionated into acid volatile sulfide, HCl-soluble sulfur, elemental sulfur, pyrite sulfur, ester sulfate and carbon-bonded sulfur and the isotopic composition of each fraction determined. In general, reduced inorganic S constitutes 25-50% of the total S in the polluted surficial sediments, but is $< 20\%$ in the unpolluted samples, with pyrite formation being a minor process of S diagenesis in lake sediment ecosystems. Organic S in the form of ester sulfate and carbon-bonded S predominates and both the C/S ratios and the isotopic data suggest that, in unpolluted lakes, plant detritus can be a major contributor of organic-S to the sediments. The depth profiles observed suggest that the more labile ester sulfate is diagenetically converted to the carbon-bonded form. For the polluted sediments from the Sudbury basin, the isotopic data suggest that (a) the elemental S is derived from the oxidation of acid volatile sulfide in the aerobic surficial sediments, and (b) the isotopically light reduced S species are incorporated into the organic material. S diagenesis in lake sediments generally results in the release of S-34 to the overlying water. The suggestion is made that sulfate concentrations over 5 mg/l accompanied by an enrichment of surficial sediments with isotopically different S may signal significant inputs of pollutant S into the lake and its basin. (Author's abstract)
W85-05763

AMBIENT HYDROGEN SULPHIDE LEVELS AT A WASTEWATER TREATMENT PLANT,
National Univ. of Singapore. Dept. of Civil Engineering.
L. C. C. Koe.
Environmental Monitoring and Assessment, Vol. 5, No. 1, p 101-108, March, 1985. 4 Fig, 1 Tab, 2 Ref.

Descriptors: *Hydrogen sulfide, *Air pollution, *Wastewater treatment facilities, *Path of pollutants, Measuring instruments, Weather, Inlet structures, Clarifiers.

This paper describes a novel technique of measuring ambient hydrogen sulfide (H2S) concentrations simultaneously at several locations around a wastewater treatment plant. A commercially purchased H2S monitor is modified to operate in a 'static mode' to enable degree of darkening on pieces of lead acetate tapes to be correlated against the exposure duration and the ambient H2S concentration of sewage air. The technique can yield mapped contours of time - average H2S concentrations as low as 0.2 ppm. The methodology is exemplified for a wastewater treatment plant in Ipswich, Queensland. Isopleths of H2S concentration obtained at the wastewater site for two different meteorological conditions reveal that high levels of H2S are detected around the plant's inlet structure and primary clarifiers. (Author's abstract)
W85-05765

COMPARISONS OF SUCCESSIVE ITERATION AND DIRECT METHODS TO SOLVE FINITE ELEMENT EQUATIONS OF AQUIFER CONTAMINANT TRANSPORT,
Oak Ridge National Lab., TN. Environmental Sciences Div.
G. T. Yeh.
Water Resources Research, Vol. 21, No. 3, p 272-280, March, 1985. 5 Fig, 4 Tab, 38 Ref. DOE contract DE-AC05-840R21400.

Descriptors: *Aquifers, *Path of pollutants, *Mathematical analysis, *Groundwater pollution, *Finite element method, Computer models, Relaxation method, Gauss-Seidel method.

Iteration techniques, including successive underrelaxation (SUR), Gauss-Seidel (G-S), and successive overrelaxation (SOR) schemes, were adapted to solve finite element equations of aquifer contaminant transport. Numerical experiments were performed to assess the convergency of these iteration schemes. When the mesh Peclet number is much less than one, all three iteration schemes generate convergent computations. When the mesh Peclet number is greater than one, only SUR and G-S schemes yield convergent calculations, whereas the SOR scheme leads to divergent computations. The relative merits of the successive iteration to direct elimination methods in terms of CPU memory and CPU time requirements are compared through two simple examples. For all practical problems, successive iteration schemes offer substantial savings in the central processing unit (CPU) memory over the direct elimination scheme, without complicating the programming; the larger the problem, the more the saving. For small problems the successive iteration schemes, if convergent, require comparable CPU time to that required by the direct elimination scheme. However, for large problems, the successive iteration schemes consume only a small fraction of the CPU time used by the direct elimination scheme. (Author's abstract)
W85-05790

FINITE ELEMENT MATRIX AND MASS BALANCE COMPUTATIONAL SCHEMES FOR TRANSPORT IN VARIABLY SATURATED POROUS MEDIA,
GeoTrans, Inc., Herndon, VA.
P. S. Huyakorn, J. W. Mercer, and D. S. Ward.
Water Resources Research, Vol. 21, No. 3, p 346-358, March, 1985. 12 Fig, 4 Tab, 24 Ref, 2 Append.

Descriptors: *Unsaturated zone, *Mass balance studies, *Path of pollutants, *Finite element method, Porous media, Computer models, Soil water.

An upstream-weighted residual finite element formulation was developed for the numerical simulation of solute transport in variably saturated porous media. This formulation includes an influence coefficient scheme for element matrix evaluation and a mass balance computation scheme. These schemes are not only simple to implement but also cost effective. Three examples provided verification of the numerical techniques and demonstrate the utility of the computer model. These examples indicate that mass balance information serves a useful purpose as a screening device for examining the numerical solution. They also show certain behavior of the mass balance error as well as numerical difficulties associated with the manner in which the finite element formulation of the transport equation is performed. Information on the CPU time and cost required to solve the three example problems indicated the cost effectiveness of the transport model. Although the analysis considers only two dimensions, the schemes can be extended to three dimensions, where the time and cost savings are more significant. (Author's abstract)
W85-05798

ASSESSMENT OF BACTEROIDES FRAGILIS GROUP ORGANISMS AS INDICATORS OF HUMAN FAECAL POLLUTION,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
K. Allsop, and D. J. Stickler.
Journal of Applied Bacteriology, Vol. 58, No. 1, p 95-99, January, 1985. 1 Fig, 5 Tab, 14 Ref.

Descriptors: *Bacteroides, *Bacteria, *Feces, *Biological indicators, *Fate of pollutants, *River Thaw, *River Ely, *Wales, Water pollution sources, Pigs, Cows, Chickens, Ducks, Dogs, Cats.

The role of Bacteroides fragilis group (BFG) organisms as indicators of fecal contamination was examined in natural, treated effluent and raw sewage water samples and their specificity as indicators of human fecal pollution was assessed by examining their numbers in the feces of various animals; membrane filtration techniques were used to enumerate BFG organisms and Escherichia coli. Water samples were collected from the relatively uncontaminated River Thaw and relatively clean coastal beach in the west of South Wales (Llantwit Major) and from the grossly polluted River Ely and the grossly polluted Penarth beach in the east of South Wales. Raw sewage and treated effluent were collected from a percolating filter plant, an activated sludge plant and a Pasveer Ditch. Fresh fecal samples from cows, pigs, chickens, ducks, dogs and cats were also collected. At a site 50 m below treated sewage input to the R. Thaw, the calculated mean density of presumptive (p) BFG was 199,000 100/ml with a pBFG:E. coli ratio of 2.29. The numbers of pBFG and the pBFG:E. coli ratio then decreased with distance so that at a site 2.4 km from the sewage outfall the ratio was 0.7. At sites on the R. Thaw above the sewage works, pBFG densities of 1000 100/ml were found with mean pBFG:E. coli ratios of 1.81 to 2.13. BFG were either absent or present in only small numbers in the animal feces samples. Pollution upstream of the sewage treatment plant on R. Thew is probably from domestic sources. The results suggest that BFG organisms die off more rapidly than E. coli in water and that animal feces are not a significant source of BFG. The ratio BFG to E. coli in water may be used to indicate the proximity of a source of human fecal contamination. (Collier-IVI)
W85-05808

ROLE OF IMMUNOASSAY IN THE ANALYSIS OF MICROCONTAMINANTS IN WATER SAMPLES,
Surrey Univ., Guildford (England). Dept. of Biochemistry.
For primary bibliographic entry see Field 5A.
W85-05811

5C. Effects Of Pollution

EFFECT OF METALS AND CYANIDE ON FERTILIZATION IN RAINBOW TROUT (SALMO GAIRDNERI),
Institut National de la Recherche Agronomique, Jouy-en-Josas (France). Lab. de Physiologie des Poissons.
R. Billard, and P. Roubaud.
Water Research, Vol. 19, No. 2, p 209-214, 1985. 6 Fig, 1 Tab, 27 Ref.

Descriptors: *Trout, *Water pollution effects, *Toxicity, *Metals, *Cyanide, *Fertilization, Growth stages, Fish eggs, Tris, Iron, Copper, Cyanide, Zinc, Life cycles.

The effects of several heavy metals and cyanide on fertilization were studied in rainbow trout. Two tests were carried out. (1) The gametes were exposed independently for 40 min to a test chemical added into diluents. The ovum diluent (ID) was a NaCl solution (osmotic pressure: 250 mOsm/kg), pH 9.0, Tris 20 mM, glycine 50 mM. The spermatozoa were diluted at 0.1 and 0.01 and the same diluent with K(+) added; they were immobile in the diluent (CD). Insemination was carried out after the gametes had been washed. (2) Ova and spermatozoa were mixed together in ID containing one of the chemicals to be tested (insemination test). In test 1 in which gametes were exposed over an extended time, the chemicals were only very slightly toxic to ova compared to sperm. Iron became toxic for ova at a concentration of 0.073 mg/l and the toxic thresholds of the other products were higher than 1 mg/l. The chemicals had a more marked toxic effect on sperm diluted at 0.01 in the following decreasing order (in mg/l): chromium 0.005, iron 0.005, cyanide 1, zinc 20. Insemination sometimes revealed lower thresholds of toxicity: chromium 0.005, iron 0.08, cyanide 0.001, mercury > 1. Copper had a favorable effect on fertilization. The tests, and particularly the insemination test, could be used to monitor the toxic effect of a chemical on a stage of the life-cycle of fish which has been little studied up to now. (Author's abstract)
W85-04976

MUTAGENIC ACTIVITY IN ORGANIC CONCENTRATE FROM NISHITAKASE RIVER WATER IN KYOTO CITY, AND ITS FRACTIONS SEPARATED BY USING LIQUID-LIQUID FRACTIONATION AND THIN LAYER CHROMATOGRAPHY,
Kyoto City Inst. of Public Health (Japan).
For primary bibliographic entry see Field 5A.
W85-04980

SIMPLE CULTIVATION UNIT FOR THE EVALUATION OF ALGAL GROWTH POTENTIAL AND TOXICITY OF WATER,
Ceskoslovenska Akademie Ved, Trebon. Dept. of Hydrobotany.
For primary bibliographic entry see Field 7B.
W85-04983

SIDE EFFECTS OF 58 YEARS OF COPPER SULFATE TREATMENT OF THE FAIRMONT LAKES, MINNESOTA,
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 5G.
W85-04996

UPTAKE OF CADMIUM BY EGGS AND ALEVINS OF ATLANTIC SALMON (SALMO SALAR) AS INFLUENCED BY ACIDIC CONDITIONS,
Department of Fisheries and Oceans, St. Andrews (New Brunswick).
R. H. Peterson, J. L. Metcalfe, and S. Ray.
Bulletin of Environmental Contamination and Toxicology, Vol. 34, No. 3, p 359-368, March, 1985. 1 Fig, 9 Tab, 11 Ref.

Descriptors: *Cadmium, *Salmon, *Hydrogen ion concentration, *Water pollution effects, Fish, Absorption, Fish eggs, Immature growth stages, Heavy metals.

The uptake of cadmium by chorion, embryo and yolk of Atlantic salmon eggs and of alevins resulting from three levels of Cd exposure, at each of four incubation pH's was examined. Cd accumulation by salmon eggs was strongly influenced by the pH of the incubation medium. The Cd levels in eggs exposed to various pH levels with no added Cd varied from 0.04 to 0.10 microg/g with no significant difference. For eggs exposed to Cd, however, Cd accumulation was strongly influenced by the ambient pH. The Cd accumulation by the salmon egg is rapid with the concentrations apparently equilibrating within the first 24 hr of exposure, compared with 48 hr for rainbow trout eggs. The distribution of Cd in the Atlantic salmon egg, after exposure to 1-5 microg/L Cd in ambient water at pH 6.8, is similar to that described for rainbow trout eggs. Examination of mean alevin lengths for the various treatments indicates the nature of the effects of low pH and Cd. In the absence of Cd, alevins were progressively smaller at lower pH levels. Alevins hatching at pH 4.5 were larger at higher ambient Cd concentrations. (Baker-IVI)
W85-05012

NITRITE TOXICITY TO THE CRAYFISH PROCAMBARUS CLARKII,
Texas Dept. of Water Resources, Amarillo.
M. P. Gutzmer, and J. R. Tomasso.
Bulletin of Environmental Contamination and Toxicology, Vol. 34, No. 3, p 369-376, March, 1985. 2 Fig, 1 Tab, 19 Ref.

Descriptors: *Nitrites, *Toxicity, *Crayfish, Respiratory pigments, Oxidation, Hemocyanin, Chlorides.

The 24-, 48-, 72-, and 96-hr LC-50's of nitrite to crayfish of different weights and genders in freshwater were determined along with the LC-50's of nitrite to crayfish in water with elevated chloride concentrations and hemolymph nitrite concentrations in crayfish exposed to nitrite in freshwater and water with elevated chloride concentrations. Results indicate that nitrite is toxic to crayfish at concentrations similar to those which are toxic to many freshwater fishes. The primary mechanism of nitrite toxicity to crayfish, however, has not yet been identified. In vertebrates, nitrite causes the oxidation of hemoglobin to methemoglobin, a form not capable of binding and transporting oxygen. The animal then suffers from a functional hypoxia. Crayfish contain the respiratory pigment hemocyanin rather than hemoglobin. Hemocyanin regularly goes through oxidation-reduction reactions as it binds and releases oxygen. The reversibility of hemocyanin oxidation-reduction coupled with the observation of extremely high levels of nitrite in the hemolymph may indicate that nitrite toxicity in crayfish is not related to oxidation of the respiratory pigment as it is in vertebrates. (Baker-IVI)
W85-05013

MORTALITY OF EARLY LIFE STAGES OF LARGEMOUTH BASS, MICROPTERUS SALMOIDES DUE TO PENTACHLOROPHENOL EXPOSURE,
Queen's Univ., Kingston (Ontario). Dept. of Biology.
P. H. Johansen, R. A. S. Mathers, J. A. Brown, and P. W. Colgan.
Bulletin of Environmental Contamination and Toxicology, Vol. 34, No. 3, p 377-384, March, 1985. 1 Fig, 1 Tab, 19 Ref.

Descriptors: *Pentachlorophenol, *Bass, *Toxicity, Organic compounds, Mortality, Biocides, Chlorinated hydrocarbons, Phenols.

The toxicity of pentachlorophenol (PCP) to various life-cycle stages of a warm water species, the largemouth bass, is reported. Long term exposures to low concentrations of PCP are used to calculate the highest PCP concentration which causes no significant increase in mortality. Between 28 and 49 days of age largemouth bass fry become significantly less tolerant to PCP poisoning. PCP is a general metabolic poison which at low concentrations uncouples oxidative phosphorylation without retarding electron transport. At higher concentrations it reduces the activity of some glycolytic enzymes while increasing the activity of some enzymes of the HMP pathway and TCA cycle along with cytochrome oxidase. A shift in some facet of energy metabolism occurs at around 30 to 40 days of age which accounts for the reduction in PCP tolerance found at this time period. For the long term exposure tests the weekly length measurements of the first 5 weeks of PCP exposure were subjected to regression analysis and a slightly reduced growth was noted at the 3 higher PCP concentrations, but this was not significant. An ich infection occurred and was most severe on fish from 83 microg/L concentrations with over 102 white spots in total while all others, including controls, ranged between 32 and 0 though not in a dose related fashion. It would appear then that the highest concentration of PCP was definitely imposing a physiological load making the fish more susceptible to infection. (Baker-IVI)
W85-05014

PENTACHLOROPHENOL AND TETRACHLOROPHENOLS IN WADDEN SEDIMENT AND CLAMS MYA ARENARIA OF THE JADEBUSEN AFTER A 14-YEAR PERIOD OF WASTEWATER DISCHARGE CONTAINING PENTACHLOROPHENOL,
Oldenburg Univ. (Germany, F.R.).
W. Butte, J. Denker, M. Kirsch, and T. Hopner.
Environmental Pollution (Series B), Vol. 9, No. 1, 29-39, 1985. 4 Fig, 3 Tab, 22 Ref.

Descriptors: *Pentachlorophenol, *Tetrachlorophenol, *Jadebusen, *Germany (Federal Republic), *Wadden sediment, *Clams, Water pollution effects, Sediments, Chlorinated hydrocarbons, Anaerobic conditions, Mollusks.

Pentachlorophenol (PCP) and tetrachlorophenol (TCP) concentrations in anaerobic Wadden sediments and clams of the Jadebusen were determined two years after the end of a long-lasting discharge of PCP into the region. Concentrations of PCP were of the same order of magnitude as those determined in sediments and organisms of the Weser estuary; concentrations after acid hydrolysis were 2-5 times higher than those of free PCP. 2,3,4,5-TCP contents exceeded those of PCP eight times in sediments and fifteen times in clams. PCP and 2,3,4,5-TCP were accumulated in clams 100- to 1000-fold compared with sediments. It is assumed that, under anaerobic conditions, a reductive dechlorination of PCP occurs, resulting in 2,3,4,5-TCP, which is more persistent than PCP in the environment under study. (Author's abstract)
W85-05028

EFFECT OF SEWAGE WITH SPECIAL REFERENCE TO AQUATIC INSECTS IN THE RIVER KSHIPRA (INDIA),
Madhav Science Coll., Ujjain (India). Dept. of Zoology.
N. Mishra, and A. B. Saxena.
International Journal of Environmental Studies, Vol. 23, No. 3/4, p 191-208, October, 1984. 3 Fig, 18 Tab, 11 Ref.

Descriptors: *Water pollution effects, *Wastewater pollution, *Aquatic insects, *Kshipra, *India, Insects, Industrial wastes, Textile industry, Water quality, Monsoons.

Insects are important organisms in the aquatic biotype and occupy almost all conceivable habitats. The river Khan receives a load of 8.5 mgd of city sewage and textile industrial wastes. After a flow of 64 km the river joins with the river Kshipra at Triveni. During the monsoon season the industrial effluents for Indore city are drained to the stream, causing detrimental effects on insect fauna and water quality. At Gaughat, the tolerant organisms have been observed only in the monsoon season because the water quality is so poor. High densities with diversified fauna were observed in late winter and summer season. A reduction in the number of species at Chakrateertyha clearly shows that raw sewage causes deleterious effects on the insect community. Tolerant organisms of Eristalis spp., Psychoda spp. and Chironomidae spp. are well adapted to the poor water quality environment. At Gaughat a highly diversified insect fauna has been noticed which clearly indicates that the water quality is normal with few exceptions. Sewage causes drastic change in the insect community structure, indirectly affecting the fish production. (Baker-IVI)
W85-05029

INTERACTIONS OF COPPER AND LEAD WITH NOSTOC MUSCORUM,
Syracuse Univ., NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W85-05040

EFFECT OF METAL-RICH SEWAGE SLUDGE APPLICATION ON THE BACTERIAL COMMUNITIES OF GRASSLANDS,
California Univ., Irvine. Environmental Analysis Div.
T. Barkay, S. C. Tripp, and B. H. Olson.
Applied and Environmental Microbiology, Vol. 49, No. 2, p 333-337, February, 1985. 3 Tab, 40 Ref.

Descriptors: *Water pollution effects, *Cadmium, *Metals, *Sewage sludge, *Grasslands, *Bacteria, *Land disposal, Wastewater disposal, Species diversity.

The effect of long-term application of heavy metal-laden sewage sludge on the total heterotrophic aerobic and the cadmium-resistant soil bacterial communities was studied. Gram-positive bacteria were completely absent from resistant communities. These findings suggest that this group is highly susceptible to Cd. Shannon's diversity indices estimated for total communities did not reveal negative effects on the communities that developed in the presence of sludge. However, Cd-resistant communities isolated form long-term sludge-amended soils were more diverse than the resistant communities from a control sample, suggesting that adaptation to Cd as a stressor had occurred in the presence of sludge constituents. This higher diversity was attributed to Cd resistance in pseudomonads and gram-negative fermenters. Resistance did not develop by dissemination of Cd resistance plasmids, because these were rarely detected in the genomes of resistant strains. (Author's abstract)
W85-05047

QUANTITY AND COMPOSITION OF PHYTOPLANKTON, PARTICULARLY CHLOROPHYTA, IN LAKES OF DIFFERENT TROPHIC LEVELS,
For primary bibliographic entry see Field 2H.
W85-05065

EFFECTS OF H2SO3 AND H2SO4 ON ANABAENA CYLINDRICA (LES EFFETS DU H2SO3 ET DU H2SO4 SUR ANABAENA CYLINDRICA (CYANOPHYTE)),
Universite Catholique de Louvain, Louvain-la-Neuve (Belgium). Unite d'Ecologie et de Biogeographie.
C. Brauwers.
Bulletin de la Societe Royale de Botanique de Belgique, Vol. 117, No. 2, p 267-276, 1984. 1 Fig, 3 Tab, 34 Ref.

Descriptors: *Sulfuric acid, *Water pollution effects, *Anabaena, Cyanophyta, Chlorophyll, Nitrogenase, Toxicity, Nitrogen fixation.

The blue-green alga was exposed during 2 hours to pure solutions of pollutants, the effects of which were examined on the chlorophyll content and synthesis and on the nitrogenase activity. On the basis of the chlorophyll content measured one day after the treatment, the lethal dose 50 is 0.13 meq/l. The nitrogenase activity is more sensitive; a reduction of 35% is observed at 0.05 meq/1. At equal pH, H2SO4 is not so toxic as H2SO3. But the acidity is particularly harmful to Anabaena; at pH ranging from 4.6 to 5.0, H2SO4 severely injures the N2 fixation. (Author's abstract)
W85-05071

TOXICITIES OF BUTOXYETHANOL ESTER AND PROPYLENE GLYCOL BUTYL ETHER ESTER FORMULATIONS OF 2,4-DICHLOROPHENOXY ACETIC ACID (2,4-D) TO JUVENILE SALMONIDS,
California State Dept. of Fish and Game, Rancho Cordova. Pesticide Investigations Unit.
B. J. Finlayson, and K. M. Verrue.
Archives of Environmental Contamination and Toxicology, Vol. 14, No. 2, p 153-160, March, 1985. 2 Fig, 4 Tab, 25 Ref.

Descriptors: *Toxicity, *Fish, *Dichlorophenoxy acetic acid, Water pollution effects, Butoxyethanol ester, Propylene glycol butyl ether ester, Herbicides, Salmon, Trout, Immature growth stages.

Continuous flow toxicity tests were conducted to determine acute toxic effects of butoxyethanol ester (BOEE) and propylene glycol butyl ether ester (PGBEE) formulations of 2,4-dichlorophenoxy acetic acid (2,4-D) on juvenile chinook salmon and steelhead-rainbow trout. A chronic toxicity test with chinook salmon egg-to-fry was conducted to determine effects of BOEE on survival and growth. The hydrolysis in water of 2,4-D esters to 2,4-D acid was influenced by the presence of fish. The PGBEE proved to be slightly more acutely toxic to salmonids than BOEE. Chinook salmon were generally more sensitive to BOEE than steelhead-rainbow trout, and fry were as sensitive as smolts. The estimated MATC for BOEE is 40 micro-g/liter for chinook salmon during continuous egg-to-fry exposure. The dynamics of 2,4-D esters in water are greatly influenced by the presence of fish. The relationship between the organism's ability to hydrolyze (detoxify) BOEE and the toxicity of BOEE needs clarification. (Baker-IVI)
W85-05105

CHOLINESTERASE ACTIVITIES IN DEVELOPING AMPHIBIAN EMBRYOS FOLLOWING EXPOSURE TO THE INSECTICIDES DIELDRIN AND MALATHION,
Universidad Nacional del Comahue, Buenos Aires (Argentina). Dept. de Quimica.
M. C. de Llamas, A. C. de Castro, and A. M. Penchen de D'Angelo.
Archives of Environmental Contamination and Toxicology, Vol. 14, No. 2, p 161-166, March, 1985. 4 Fig, 2 Tab, 21 Ref.

Descriptors: *Malathion, *Dieldrin, *Amphibians, *Water pollution effects, Insecticides, Toads, Embryos, Behavior, Chloinesterase.

An attempt was made to determine the effect of malathion and dieldrin on amphibian embryo cholinesterase. Toad embryos were exposed to dieldrin and malathion during development. Dieldrin treatment induced hyperactivity in the swimming larvae. Malathion showed no detectable behavioral effects. In vivo adsorption of dieldrin by the oocyte produced delayed toxicity in the embryo. In vitro inhibition of AChE was not sigificant. Embryogenesis was interrupted by 47.3 mg/liter of malathion in the medium. But 0.47 mg/liter permitted the embryos to complete their development without the appearance of any observable malformations. (Baker-IVI)
W85-05106

DETECTION AND ANALYSIS OF INTERACTIONS BETWEEN ATRAZINE AND SODIUM PENTACHLOROPHENATE WITH SINGLE AND MULTIPLE ALGAL-BACTERIAL POPULATIONS,
Waterloo Univ. (Ontario). Dept. of Biology.
R. E. Burrell, W. E. Inniss, and C. I. Mayfield.
Archives of Environmental Contamination and Toxicology, Vol. 14, No. 2, p 167-177, March, 1985. 8 Fig, 3 Tab, 32 Ref.

Descriptors: *Toxicity, *Algae, *Bacteria, *Atrazine, *Sodium pentachlorphenate, Organic compounds, Insecticides, Water pollution effects, Microcosms.

A multispecies-multitoxicant batch culture test system was examined in detail through the study of its component parts. The toxicants used were sodium pentachlorophenate and atrazine and the test organisms were the green algae Ankistrodesmus braunii and Chlorella vulgaris, and the bacterium Chromobacterium violaceum. Amensalism occurred between the two algae in mixed cultures. A. braunii was inhibited by the C. vulgaris and the C. vulgaris was unaffected by A. braunii. Sodium pentachlorophenate and atrazine interacted additively, over a wide range of concentrations, with the individual algae. When both algae and both toxicants were in the microcosm, synergism was noted between Na-PCP and C. vulgaris; this synergistic interaction was modified by the presence of atrazine. The Na-PCP and atrazine interacted antagonistically with both algae as the net atrazine toxicity decreased significantly with increasing concentration of Na-PCP. The presence of the bacterium C. violaceum had no effect on the antagonistic interaction of the two toxicants with A. braunii. These results clearly demonstrate that the types of interaction observed in a complex population are directly related to several factors including the type and number of organisms and the type and number of toxicants present in the test system. The application of the graphical technique of Burrell and Corke (Bull. Environ. Contam. Toxicol. Vol. 25, p 554-561, 1980) simpified determinations of interactions in complex microcosms. (Baker-IVI)
W85-05107

IONOREGULATORY AND TOXICOLOGICAL RESPONSES OF STONEFLY NYMPHS (PLECOPTERA) TO ACIDIC AND ALKALINE PH,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
R. A. Lechleitner, D. S. Cherry, J. Cairns, and D. A. Stetler.
Archives of Environmental Contamination and Toxicology, Vol. 14, No. 2, p 179-185, March, 1985. 6 Fig, 1 Tab, 33 Ref.

Descriptors: *Toxicity, *Stoneflies, *Nymphs, *Acidic water, *Alkaline water, Water pollution effects, Hydrogen ion concentration, Bioassay, Aquatic insects.

In the present study 96 hr static bioassays were used to determine the toxicity of extreme pH to nymphs of three species of stoneflies. The effect of low pH on the regulation of major cations by Pteronarcys proteus was determined, and alterations in gill tissue ultrastructure were observed in nymphs of P. dorsata exposed to extreme pH. The acidic and alkaline 96 hr LC50 values were 2.8 to 3.3 and 12.1 to 10.3, respectively. Exposure to pH 3.0 for 72 hr or longer caused a significant loss of sodium from nymphs of P. proteus. Morphological changes, including distension of cuticular disk and increased number of vesicles, were observed in gill tissue from nymphs of P. dorsata exposed to pH 2.5 for 9 hr while minor changes were observed in nymphs exposed to pH 4.0 for 96 hr. Changes in gill tissue ultrastructure included an increase in number of vesicles and a decrease in number and size of mitochondria in nymphs exposed to alkaline pH of 11.75. (Baker-IVI)
W85-05108

METALS IN RIPARIAN WILDLIFE OF THE LEAD MINING DISTRICT OF SOUTHEASTERN MISSOURI,
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
K. R. Niethammer, R. D. Atkinson, T. S. Baskett, and F. B. Samson.
Archives of Environmental Contamination and Toxicology, Vol. 14, No. 2, p 213-223, March, 1985. 2 Fig, 7 Tab, 30 Ref.

Descriptors: *Lead, *Mining wastes, *Wildlife, *Missouri, Vertebrates, Trophic levels, Fate of pollutants, Riparian zone, Water pollution effects, Birds, Muskrats, Frogs, Snakes.

Information was sought on heavy metals in riparian vertebrates primarily representing upper trophic levels within the Big River drainage. Big River is subject to metal pollution via erosion and seepage from large tailings piles from inactive lead mines. Bullfrogs, muskrats, and green-backed herons collected downstream from the source of metal contamination to Big River had significantly higher lead and cadmium levels than specimens collected at either an uncontaminated upstream site or on Black River. Elevated lead levels were noted in northern water snakes below the tailings source, but cadmium did not seem to be accumulated. Northern rough-winged swallows did not seem to have levels of lead, cadmium, or zinc related to collecting locality. Differences between zinc concentrations in vertebrates collected from contaminated and uncontaminated sites were less apparent than differences in lead and cadmium. Downstream from the source of tailings, bullfrogs had

markedly higher levels of these metals in most of their tissues. (Baker-IVI)
W85-05110

NATIONAL PESTICIDES MONITORING PROGRAM: RESIDUES OF ORGANOCHLORINE CHEMICALS IN FRESHWATER FISH, 1980-1981,
Columbia National Fisheries Research Lab., MO.
For primary bibliographic entry see Field 5B.
W85-05111

EFFECTS OF DEICING SALTS ON WATER CHEMISTRY AND VEGETATION IN PINHOOK BOG, INDIANA DUNES NATIONAL LAKESHORE,
National Park Service, Omaha, NE. Midwest Region.
D. A. Wilcox.
Research/Resources Management Report MWR-2, August 1982. 139 p, 32 Fig, 19 Tab, 127 Ref, 1 Append.

Descriptors: *Water pollution sources, *Salts, *Water pollution effects, *Peat bogs, *Ecological effects, *Fate of pollutants, *Path of pollutants, *Vegetation effects, Sodium chloride, Chemical properties, Path of pollutants, Mosses, Environmental effects, Environmental impact statement, Vegetation regrowth, Revegetation, Salt tolerance, Salinity, Salt intrusion, *Indiana, Deicers, *Road salting effects.

A study was conducted in 1979-1981 to identify the effects of salt intrusion from a road-salt storage pile on water chemistry and vegetation in Pinhook Bog, La Porte Co, Indiana, and to determine the fate of salt and any resulting yearly changes in water chemistry or vegetation patterns. The impacted area showed salt concentrations as high as 468 milligrams/liter Na and 1215 milligrams/liter Cl within the plant root zone of the peat mat. The salt concentrations in the root zone decreased significantly each year from 1979 to 1981. Analysis of salt movement suggested that the salt was transported vertically downward by water movement through the peat mat following snow melt and heavy precipitation events each spring. Vegetation surveys in 1980 showed an absence of numerous native species in the salt impacted area; these were replaced by invading species. By 1981, many extirpated species had become reestablished in the impacted area after declines in salt concentrations. Salt tolerance studies on Sphagnum recurvum showed reduced growth in length at NaCl concentrations found in the bog.
W85-05123

FINAL REPORT ON EFFECT OF FENTHION ON SELECTED ESTUARINE SPECIES RELATED TO FIELD STUDY,
Environmental Research Lab., Gulf Breeze, FL.
G. E. Walsh.
Report EPA-600/X-84-082, May 1984. 5 p, 1 Tab.

Descriptors: *Water pollution effects, *Estuaries, *Fenthion, *Sensitivity analysis, Cyprinodon variegatus, Menidia beryllina, Mysidopsis bahia, Paleomentes pugio, Penaeus duorarum, Fish, Invertebrates, Toxicity, Estuarine species, Sensitivity analysis.

Effects of the mosquito adulticide, fenthion, were studied through a series of acute tests with five estuarine species: Cyprinodon variegatus (Sheepshead minnow), Menidia beryllina (Inland Silverside), Mysidopis bahia (Mysid shrimp), Paleomentes pugio (Grass shrimp) and Panaeus duorarum (Pink shrimp). LC 50 values (calculated concentrations lethal to 50% of the test organisms) established the sensitivity of each organism and the range of concentrations at which these common test organisms might be affected. LC 50 values are reported in micrograms of fenthion in 1.0 l of seawater (ppb) after 24, 48, 72 and 96 h of exposure. Mysidopsia bahia and P. duorarum were approximate 3000-4500 times more sensitive than fishes in the 24 h static test. Fish showed an almost immediate response when exposed to fenthion. For M. Beryllina there were signs of distress within the 3rd or 4th h of exposure. Cyprinodon variegatus showed similar effects by the 8th h of exposure. Mortality occurred quickly in fish, between the 4th and 16th h, tapering off to almost no fatalities after 24 and 48 h. The only invertebrate to show effects before 8 to 16 h was the penaeid. Unlike fishes, mortality in invertebrates usually occurred after 16-24 h, with continued mortality to 48h (static test). Flow-through tests to the penaeid did not differ from the static test. However, the mysid was almost twice as sensitive in flow-through tests in static test.
W85-05124

ETHYLBENZENE, ENVIRONMENTAL AND TECHNICAL INFORMATION FOR PROBLEM SPILLS.
Environmental Protection Service, Ottawa (Ontario).
For primary bibliographic entry see Field 5D.
W85-05126

EFFECTS OF CARCINOGENS, MUTAGENS, AND TERATOGENS ON NONHUMAN SPECIES (AQUATIC ANIMALS),
Environmental Research Lab., Gulf Breeze, FL.
J. A. Couch, W. P. Schoor, W. Davis, and L. Courtney.
Fourth Annual Report, NCI/EPA Collaborative Program, Fiscal Year 1982; Report EPA-600/9-83-005. 46 p, 5 Fig, 9 Tab.

Descriptors: *Carcinogens, *Mutagens, *Teratogens, Toxicity, Bioindicators, Pollutant Identification, Field Tests, Metabolisms, Water pollution effects.

Aquatic systems and organisms are under both laboratory and field study in order to develop indicator, screening, and modeling capabilities for detection and evaluation of risks of carcinogens, mutagens, and teratogens. Several advances have been made in the development of laboratory and field carcinogen assays, utilizing fishes such as the sheepshead minnow (liver lesions via benzidine and aflatoxin exposures), Menidia penisulae (liver lesions via aflatoxin exposures), and freshwater cat fish (papillomatous-like lesions via chlorinated effluent exposures). Emphasis is still placed on the development and utilization of critical life stage exposures (e.g., embryo and newly hatched fry exposures) in order to expedite carcinogen tests and minimize time required for tumorogenic responses. Preneoplastic hepatic lesions development in Menidia at 12 weeks suggests promise for this species and exposure method. A novel approach has shown that tiger salamanders may be good biochemical and histologic indicators of the presence of certain carcinogens (polycyclic aromatic hydrocarbons-PAH's). Considerable field monitoring work on mollusks and carcinogenic PAH's along the coast of Oregon has revealed a positive correlation between prevalence of cellular proliferation disorders in shell-fish and higher concentrations of certain PAH's in natural water. These studies reveal that fish have metabolic pathways similar to mammals for disposition of certain carcinogens. A brief study was conducted to determine possible interactions between the 9-OH BaP and salmon sperm DNA. The interaction between salmon DNA and 9-OH BaP was shown by relative fluorescence studies.
W85-05128

COMPARATIVE ANALYSES OF FISH POPULATIONS IN NATURALLY ACIDIC AND CIRCUMNEUTRAL LAKES IN NORTHERN WISCONSIN,
Columbia National Fisheries Research Lab., La Crosse, WI. Field Research Station
J. G. Wiener.
Report FWS/OBS-80/40.16, Air Pollution and Acid Rain Report 16, September 1983. 107 p, 6 Fig, 21 Tab, 151 Ref, 20 Append.

Descriptors: *Acid rain, Lake fisheries, *Hydrogen ion concentration, *Sublethal effects, *Water pollution effects, Heavy metals, Mercury, Lead, Population exposure, Wisconsin.

Fish populations in six naturally acidic (autumnal pH 5.1-6.0) and six circumneutral (autumnal pH 6.7-7.5) clear-water lakes in north central Wisconsin were studied, and characteristics of fish populations and communities in the lakes were compared. The two groups of lakes were morphologically similar and of the same hydrologic types, but differed substantially in pH, alkalinity, waterborne calcium, and related chemical characteristics. Fish communities in the acidic lakes contained fewer species, and common as well as rare species occurred with lower frequency in the acidic lakes than in the circumneutral lakes. Certain taxa, such as minnows and darters were well represented in the circumneutral lakes, but were absent or scarce in the acidic lakes. Growth, condition, and serum calcium concentrations of bluegills were negatively correlated with population density and were not related to either pH or waterborne calcium concentrations in these lakes. Results of serum calcium analyses suggested that white suckers were stressed in lakes with autumnal pH equal to or less than 5.6 and waterborne calcium equal to or less than 2.0 mg/l. Mean concentrations of Cd and Pb in whole, 4-year-old bluegills were inversely correlated with both pH and waterborne calcium concentration. Mercury levels in axial muscle tissues of walleyes from two acidic lakes were substantially higher than in walleyes of the same age from three circumneutral lakes and exceeded the 1.0 micro g/g USFDA Action Level in about 35% of the fish analyzed.
W85-05132

EFFECT OF OIL POLLUTION ON PROCESSES OCCURRING IN WATER BASINS,
V. V. Bogorodskii, and M. A. Kropotkin.
Water Resources, Vol. 11, No. 1, p 89-94, January-February, 1984. 3 Fig, 23 Ref. Translated by Vodnye Resursy, No. 1, p 161-168, January-February, 1984.

Descriptors: *Water pollution effects, *Oil spills, *Oil pollution, Evaporation, Marine environment, Solar radiation, Atmospheric physics, Toxicity, Waves, Gas exchange, Temperature effects, Melting.

Data on the effect of oil pollution on biological and physicochemical processes occurring in a water basin are reviewed and the results are presented of a study of the effect of oil pollution on the penetration of solar radiation into water masses and on the temperature of the water surface. Oil films slow the process of evaporation, still waves on the water surface, disturb gas exchange between the atmosphere and ocean, attenuate the ultraviolet and photosynthetic components of solar radiation penetrating the water, under certain conditions can lead to a change in the surface temperature by several degrees, and affect a number of other physicochemical processes occurring on the surface of the basin and in the water column. They also have a substantial effect on the thermal regime and process of melting of the snow-ice cover, on interaction of the atmosphere and ocean, and on marine fauna and flora. Thus, oil films pose a serious potential danger. (Baker-IVI)
W85-05151

OIL SPILLS: WHAT HAVE WE LEARNED,
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
J. H. Vandermeulen.
In: Oil and Dispersants in Canadian Seas: Research Appraisal and Recommendations, EPS 3-EC-82-27, May 1982, Environmental Protection Service, Ottawa (Ontario). p 29-46, 3 Tab.

Descriptors: *Oil spills, *Water pollution effects, *Environmental effects, *Cleanup operations, *Dispersants, *Oil pollution, *Marine environment, *Fate of pollutants, Ecological effects, Oil slicks, Reviews, Salt marshes, Oil, Marine sediments, Bays.

Four oil spills in Canadian marine waters have been the site of research studies - the 1970 ARROW spill, the 1973 Alert Bay spill, the 1974 GOLDEN ROBIN spill and the recent 1979 KUR-

DISTAN spill. In the ARROW spill, the water column took the initial brunt of the oil spill. However, the underlying bottom sediments became the long-term reservoirs for the spilled oil. Wave erosion and other natural actions aided in the rapid cleanup of shorelines following the ARROW spill. Similarly, effects of the Alert Bay spill were well diminished 1 yr after the spill. The Chaleur Bay salt marsh which was oiled in the GOLDEN ROBIN spill has shown very little recovery. The KURDISTAN spill on the Cabot strait provided an opportunity to examine the interaction of oil with ice. Dispersants have been used experimentally during the ARROW spill cleanup and the GOLDEN ROBIN spill cleanup. A number of commerically available dispersants were tested during the ARROW operation for effectiveness and toxicology. It was concluded that BP1100B was effective in removing Bunker C crude oil on the surface. In the case of the GOLDEN ROBIN, none of the four dispersants tested enhanced oil penetration into marsh sediments. The AMOCO CADIZ spill and the METULA spill are foreign spills that provide information that may be applicable to Canadian shorelines. More research should be done on Canadian and foreign spills. Follow-up studies of countermeasures to handle oil spills should be undertaken along with long-term environmental impact studies.
W85-05223

SANITARY SIGNIFICANCE OF INCREASES IN FECAL COLIFORM COUNTS ACROSS A CATFISH AQUACULTURE SYSTEM,
Pape-Dawson, San Antonio, TX.
D. W. Bennett, and J. A. Gordon.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 39-45. 5 Fig, 10 Ref.

Descriptors: *Aquaculture, *Sanitation, Salmonella, Klebsiella, Shigella, Catfish farming, Gallatin, Tennessee.

The presence of Klebsiella pneumonia in the effluent of a pilot catfish facility, located at the TVA Gallatin Stream Plant near Gallatin, Tennessee, constituted a potential public health problem. This defined fecal coliform is not only an indicator organism, but is itself highly pathogenic. More than 50% of presumed fecal coliforms isolated for study were identified as K. pneumonia. Also, Salmonella and Shigella should increase across the system if they were present in the influent. This problem, however, exists only for 2-4 of the very warmest weeks of the growing season. The public health threat from this source is minimal. It was suggested that a cationic surfactant in the sedimentation pond be studied as a disinfectant, if needed. Another factor that may be employed to lower fecal coliform counts is to increase the food-to-fish ratio during this period of time. Maintenance of catfish density around 7.5 lb/cu ft was suggested.
W85-05228

ENVIRONMENTAL CONTAMINANTS ACT: HAZARD ASSESSMENT REPORT ON CADMIUM.
Environmental Protection Service, Ottawa (Ontario).
Report 83-EHD-101, EPS 3-EP-83-9, December 1983, 38 p, 27 Ref, 2 Append.

Descriptors: *Environmental protection, *Water pollution effects, *Environmental impact statement, *Cadmium, *Water pollution control, *Literature review, *Fate of pollutants, Lethal limit, Heavy metals, Toxicity, Hazardous materials, Toxins, Metabolism, Reviews, Population exposure, Drinking water, Waste disposal, Environmental Contaminants Act, Canada.

An investigation was made jointly by the Department of National Health and Welfare and the Department of the Environment under the authority of Subsection 3(3) of the Environmental contaminants Act to determine whether activities related to the production and use of Cd and its compounds in Canada represent a significant danger to human health or the environment. The methodology of hazard assessment included a critical review of recent published and unpublished information and a comparison of existing concentrations of Cd in a variety of environmental media, biota, and humans with those concentrations representative of significant danger. On the basis of the best available information, there is insufficient evidence of hazard to warrant the implementation of national regulatory control action pursuant to the Environmental Contaminants Act at this time. However, this determination does not preclude the future use of the Environmental Contaminants Act for the control of Cd, particularly for local pollution problems in the vicinity of large discharge sources; nor does it diminish the need for existing control program associated with other statutes, or for measures to minimize releases of Cd.
W85-05302

PLANKTON OF TWIN LAKES, COLORADO,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
For primary bibliographic entry see Field 2H.
W85-05303

EFFECTS OF OPERATING THE MT. ELBERT PUMPED-STORAGE POWERPLANT ON TWIN LAKES, COLORADO: 1981 REPORT OF FINDINGS,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
For primary bibliographic entry see Field 2H.
W85-05304

HERBICIDAL RESIDUES AND ENVIRONMENTAL EFFECTS FROM THE EXPERIMENTAL APPLICATION OF TWO 2,4-D FORMULATIONS TO CONTROL EURASIAN WATERMILFOIL,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
N. E. Otto, J. C. Pringle, and D. Sisneros.
Available from the National Technical Information Service, Springfield, VA 22161. Report REC-ERC-83-1. July 1983. 97 p, 41 Fig, 36 Tab, 15 Ref, 2 Append.

Descriptors: *Aquatic weed control, *Aquatic weeds, *Weed control, *Herbicides, *Organic pesticides, *Pesticides, *Ecological effects, *Pesticide residues, *Fate of pollutants, Path of pollutants, Aquatic environment, Water quality, Phytoplankton, Zooplankton, Water analysis, Chemical analysis, Gas chromatography, 2-4-D, Eurasian Watermilfoil, Banks Lake, Fort Cobb Reservoir, Washington, Oklahoma, Myriophyllum spicatum.

In response to the need for an effective and environmentally acceptable herbicide to control eurasian watermilfoil, a serious aquatic weed problem and interagency research study was initiated involving the USBR (Bureau of Reclamation) and the COE (U. S. Army Corps of Engineers). The tolerance and label amendment efforts done by the USBR are reported. Experimental small-plot applications of 2,4-D dimethylamine (DMA) and butoxyethanol ester (BEE) at rates of 20 and 40 lb. acre (22.5 and 45 kg/ha) were made at Banks Lake, Washington and Fort Cobb Reservoir, Oklahoma with subsequent water, hydrosoil, invertebrate organism, and fish flesh sample collection and analysis for residues, through 56-days posttreatment. The temporary potable water tolerance of 0.1 milligram/liter was exceeded in three 1-day posttreatment samples (of 1680 water samples analyzed of 0.18% of the total samples). No dichlorophenols were found in water, but dimethylnitrosamines in the microgram/liter range were detected in a few pretreatment and posttreatment samples from both sites. Hydrosoil 2,4-D residues were low, with concentrations ranging from 0 to 0.316 micrograms/gram of soil resulting from a 45 kilogram/ha BEE application. Trace amounts of 2,4-D dichlorophenol in the microgram/liter range were found in some hydrosoil pretreatment and posttreatment samples. Herbicide residues in fish flesh were well within the 1 milligram/liter food additive tolerance, with no evidence of bioaccumulation.
W85-05308

LIMING OF ACIDIFIED WATERS: A REVIEW OF METHODS AND EFFECTS ON AQUATIC ECOSYSTEMS,
General Research Corp., McLean, VA.
J. E. Fraser, and D. L. Britt.
Fish and Wildlife Service Report FWS/OBS 80/40.13; Air Pollution and Acid Rain Report 13, December 1982. 189 p, 29 Fig, 43 Tab, 251 Ref, 3 Append.

Descriptors: *Acid rain, *Acidic water, Acidification, Acid streams, *Lime, *Neutralization, *Fish management, *Fish, *Ecosystems, Reviews, Ecological effects, Fisheries, Water quality management, Resources management, Water management, Environmental effects, Hydrogen ion concentration, Alkalinity, Acidity, Chemical properties, Project planning.

The Interagency Task Force on Acid Precipitation which was established under the Acid Precipitation Act of 1980 has analyzed mitigation methods for acidified surface waters as part of a 10-yr National Acid Precipitation Assessment Plan. The leaching of Al into surface waters under acid conditions has proven toxic to fish. Liming has been used successfully to enhance the biological recovery of aquatic ecosystems affected by acidification. Aglime is the preferred form of liming agent for surface waters due to its ease of handling and low cost. Cost for liming projects vary and depend on planning and material costs, method of application, size and location of the surface water body, quality of surface waters and their catchment areas, acid loading rate, reapplication rate and water quality monitoring costs. Several design aspects and problems associated with liming should be considered before such a project is initiated. Liming should be chosen as a management option only when surface water has low alkalinity and high acidic input, the lake or stream is an important source for food or game fish or represents an important recreational resource, there are few confounding physical, chemical or biological factors, or the project costs are favorable compared to other options.
W85-05310

MODELING OF TOTAL ACID PRECIPITATION IMPACTS.
Acid Precipitation Series, Vol. 9, 1984. Butterworth Publishers, Boston. Edited by Jerald L. Schnoor. 222 p.

Descriptors: *Model studies, *Model testing, *Acidification, *Water pollution sources, *Fate of pollutants, *Acid rain, *Acidic water, *Mathematical models, *Lakes, *Air pollution effects, Environmental impact statement, Environmental effects, Ecological effects, Chemical properties, Water pollution effects, Hydrogen ion concentration, Acidity, Neutralization.

This volume presents reports given at the American Chemical Society's symposium on acid precipitation held in Las Vegas in the spring of 1982. Report topics include: atomospheric trajectory models for diagnosing the sources of acid precipitation, Eulerian modeling of the transport and chemical processes affecting long-range transport of sulfur dioxide and sulfate, weak acid/base systems in dilute acidified lakes and streams of the Adirondack region of New York State, an overview of Norwegian models for surface water chemistry, modeling the interrelationship of groundwater and surface water, modeling the reacidification rates of neutralized lakes near Sudbury, Ontario, modeling impacts of acid precipitation for Northeastern Minnesota, development and calibration of the integrated lake-watershed acidification study model and a U. S./Canada aquatic impacts assessment through the integration of experimental studies, modeling and monitoring of acidic deposition effects.
W85-05313

WEAK ACID/BASE SYSTEMS IN DILUTE ACIDIFIED LAKES AND STREAMS OF THE ADIRONDACK REGION OF NEW YORK STATE,
Syracuse Univ., NY. Dept. of Civil Engineering.

For primary bibliographic entry see Field 2H.
W85-05316

U. S./ CANADA AQUATIC IMPACTS ASSESSMENT: INTEGRATION OF EXPERIMENTAL STUDIES, MONITORING AND MODELING OF ACIDIC DEPOSITION EFFECTS,
Institute of Ecology, Indianapolis, IN.
For primary bibliographic entry see Field 2A.
W85-05322

BIOLOGICAL EFFECT OF SOME POISONS ON CANTHOCAMPTUS (CRUSTACEA SPP),
All-India Inst. of Hygiene and Public Health, Calcutta. Dept. of Sanitary Engineering.
S. V. R. Rao, and K. J. Nath.
International Journal of Environmental Studies, Vol. 21, No. 3/4, p 271-275, October, 1983. 5 Tab, 9 Ref.

Descriptors: *Water pollution effects, *Toxicity, *Crustaceans, Water quality control, Bioassays, Manganese, Phenols, Copper, Larvae.

The biological effect of some toxicants which are usually present in industrial waste discharge are considered as they pertain to a crustacean larva, Canthocamptus spp. The toxicants tested included copper (as copper sulfate), phenol, manganese (as manganese sulfate), individually and in combination. When exposed to individual toxicant concentrations, manganese exerted its toxicity even at a very low concentration followed by copper and phenol. In combination with copper and phenol, manganese increased the toxicity even at very low concentrations. In combination with copper, manganese caused the death of the organisms even at a low concentration of 0.005 mg/l Mn. Conversely, copper in combination with manganese was able to cause the death of the organisms, even at low concentrations of 0.1 mg/l Cu. Mn (2+) in combination with phenol proved lethal to the organism at very low concentrations. Quality control standards must be designed for the discharge of the effluents into the aquatic ecosystems such that they should take into consideration the additive, antagonistic and cumulative effect of the toxicants. (Baker-IVI)
W85-05446

EUTROPHICATION AND THE BALTIC SEA: CAUSES AND CONSEQUENCES,
Stockholm Univ. (Sweden). Dept. of Zoology.
U. Larsson, R. Elmgren, and F. Wulff.
Ambio, Vol. 14, No. 1, p 9-14, 1985. 2 Fig, 7 Tab, 65 Ref.

Descriptors: *Eutrophication, *Baltic Sea, Phosphorus, Nitrogen, Nutrients, Denitrification, Sediments, Water pollution effects, Water pollution sources, Phytoplankton, Atmospheric deposition, Industrial wastes, Municipal wastewater, Rivers.

The Baltic Sea is a semi-enclosed, brackish sea surrounded by highly industrialized countries and close to major sources of air pollution in central Europe. Baltic pollution problems have been recognized for some time. Observations of the problem prompted the National Swedish Environment Protection Board to make a scientific assessment of the causes and consequences of eutrophication in marine waters surrounding Sweden. The primary effect of the increased nutrient load is a higher phytoplankton primary production, with blooms maintained during the whole vegetation period. For the open Baltic proper, the rapid decrease in oxygen content of the deep water following World War II and the prevailing anoxic conditions during the last 25 years may be a sign of eutrophication. The estimated total annual loads to the Baltic are 78,000 tons P and 1,190,000 tons N, including both land-based load and airborne deposition. For phosphorus, the main inputs are from rivers and municipal sources, whereas industry and atmospheric fallout play minor roles. For nitrogen, the atmospheric input is nxt in importance to the rivers. the internal source, through nitrogen fixation is about equal to the direct municipal input. Nutrient budgets indicate that a considerable phosphorus accumulation must be taking place in the Baltic sediments. For nitrogen, increased loading and nitrogen fixation may partly be counteracted by increased denitrification, resulting in a relatively small net accumulation. (Baker-IVI)
W85-05464

FISH DEFORMITIES AND POLLUTION IN SOME SWEDISH WATERS,
National Swedish Environment Protection Board, Nykoeping. Brackish Water Toxicology Lab.
B.-E. Bengtsson, A. Bengtsson, and M. Himberg.
Ambio, Vol. 14, No. 1, p 32-35, 1985. 2 Fig, 2 Tab, 43 Ref.

Descriptors: *Sweden, *Water pollution effects, *Fish, Animal pathology, Arsenic, Metals, Morphology, Deformities.

Results of studies on morphological and skeletal deformities in fish are reviewed. The use of morphological anomalies in fish to monitor water pollution has been suggested by several researchers. The Skelleftea Bay and Adjacent area of the Bothnian Bay have been contaminated by arsenic and metals from a complex of sulfide ore smelters. In a project called Fish and Metal Pollution, a set of methods developed in the laboratory was selected for a field monitoring program to detect possible sublethal effects of exposure to pollution in fish. Specific topics covered in the Fish and Metal Pollution project, and highlighted in this report, include: meristic and morphological characters used to detect pollution (anatomical asymmetry, spinal and vertebral deformities); choice of test species; observed effects (asymmetry and deformities of fins and gill rakers, and spinal and vertebral deformities). The four-horned sculpin was chosen as a test species. (Baker-IVI)
W85-05466

MODULAR INTERACTIVE SIMULATION SYSTEM FOR EUTROPHICATION AND REGIONAL DEVELOPMENT,
Minnesota Univ., Minneapolis. Dept. of Agricultural and Applied Economics.
K. Fedra.
Water Resources Research, Vol. 21, No. 2, p 143-152, February, 1985. 6 Fig, 11 Ref.

Descriptors: *Water resources development, *Water management, *Eutrophication, Simulation, Computers, Federal water projects, Cost anaysis, Financial aspects.

An interactive, policy-oriented simulation and information system including videographics is introduced. The system is designed as a tool for learning about large, complex, regional environmental systems. A high degree of flexibility is achieved through the use of simple modules, describing elements of the system at various levels of detail and resolution. Background information from a historical data base drives the default evolution of the system. Simulation of alternative courses of action is possible at various hierarchical levels of management or policy making. The simulations and the display of results are controlled by an interactive, dialogue-oriented, user interface. This includes videographics with geographical or statistical information. The approach is discussed in terms of a pilot application project, dealing with a lake-watershed system having conflicts between water quality and regional development goals. (Baker-IVI)
W85-05494

WATERBORNE DISEASE IN COLORADO: THREE YEARS' SURVEILLANCE AND 18 OUTBREAKS,
Colorado Dept. of Health, Denver. Disease Control and Epidemiology Div.
For primary bibliographic entry see Field 5F.
W85-05521

POLLUTION CONTROL IMPLICATIONS OF FLUIDIZED BED TECHNOLOGY FOR COAL-FIRED STEAM ELECTRIC POWER GENERATION,
CH2M Hill Canada Ltd., Calgary (Alberta).
Report No. EPS 3-WP-82-2, March 1982. Environmental Protection Service, Ottawa, Ontario. Water Pollution Control Directorate. 114 p, 20 Fig, 31 Tab, 1 Append., 46 Ref.

Descriptors: *Fluidized bed process, *Water pollution control, *Water pollution effects, *Electric power, *Electric power production, *Coal, Environmental protection.

Combustion of coal in conventional pulverized coal fired (PCR) steam-electric power generating stations results in the emission of atmospheric contaminants which include sulfur dioxide, particulates, and trace elements and compounds. To meet pending regulatory limits for the emission of sulfur dioxide, PCF stations will require flue gas desulfurization (FGD) facilities when burning medium to high-sulfur coals. While this technology has been successfully demonstrated, most FGD systems produce a wet, relatively hard-to-handle sludge, and significant problems with equipment reliability have been encountered. Fluidized bed (FB) combustion technology has been proposed as a viable alternative to conventional PCF combustion, since low-grade, high-sulfur coals can be burned in FB boilers without the problems associated with FGD. This study examines the energy conversion efficiency, air emissions, solid waste production, water requirements, wastewater production, and general environmental protection requirements of a model 400-MW atmospheric fluidized bed station. These aspects are compared to those of a conventional PCF station of the same size equipped with FGD and state-of-the-art environmental control facilities. The results suggest that FB technology is a feasible alternative to conventional PCF technology where FGD is required to control sulfur dioxide emissions. The greatest potential application appears to be with medium to low-sulfur coals, where moderate calcium-to-sulfur ratios are required.
W85-05575

ECOSYSTEM DEFINITION AND COMMUNITY STRUCTURE OF THE MACROBENTHOS OF THE NEMP MONITORING STATION AT PIGEON HILL IN THE GULF OF MAINE,
New Hampshire Univ., Durham. Dept. of Zoology.
For primary bibliographic entry see Field 2L.
W85-05580

EFFECT OF WATER CHLORINATION ON THE TOXICITY OF COPPER TO PHYTOPLANKTON,
Maryland Univ., Solomons. Center for Environmental and Estuarine Studies.
J. G. Sanders.
Available from the National Technical Information Service, Springfield, VA 22161, as PB83-112151, Chesapeake Biological Laboratory, June 1982. 71 p. 12 Fig, 14 Tab, 1 Append, 39 Ref.

Descriptors: *Chlorination, *Copper, *Phytoplankton, *Toxicity, Powerplants, Aquatic plants, Metals, Organic carbon, Salinity, Oxidation, Estuaries.

The application of Cl to estuarine waters usually results in oxidation of a finite quantity of organic carbon, averaging 35 microM. The quantity of carbon oxidized is independent of the concentration of Cl added. The quantity of carbon associated with the smallest molecular weight fraction increased after chlorination. Field samples collected around an actively chlorinating power plant exhibited similarly sized differences in dissolved organic carbon (DOC) concentrations, about 20 microM, between intake and discharge areas. Mass balance calculations suggest that power plant chlorination could oxidize 2 x 10 to the 7th power, moles C/yr, about 11-40% of the total DOC entering the river in freshwater flow. Cu distributions within various size fractions of natural organics did not change significantly after chlorination. The quantity of carbon oxidized is small compared to the total complexation capacity of estuarine waters. Therefore, significant shifts in metal speciation should not occur due to loss of organic complexes. Copre-

cipitation of Cu with other metal oxyhydroxides does occur, may be enhanced by chlorination, and can represent a significant transport mechanism. Bioassays of relative Cu toxicity in control and chlorinated water were hampered by the extreme effect of the Cl itself. Even after 35 days, enough Cl residuals were present to impede growth of all but the most resistant algal species. Chemical dechlorination was unsuccessful because of Cu complexation reactions.
W85-05581

OIL AND DISPERSANTS IN CANADIAN SEAS: RESEARCH APPRAISAL AND RECOMMENDATIONS.
Environmental Protection Service, Ottawa (Ontario).
For primary bibliographic entry see Field 5B.
W85-05583

MICROORGANISMS AND THE DEGRADATION OF OIL UNDER NORTHERN MARINE CONDITIONS,
Alberta Univ., Edmonton. Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W85-05585

EFFECTS OF PETROLEUM HYDROCARBONS ON PHYTOPLANKTON AND MACROPHYTES,
Department of Indian Affairs and Northern Development, Ottawa (Ontario).
For primary bibliographic entry see Field 5B.
W85-05586

ZOOPLANKTON,
Environmental Protection Service, Halifax (Nova Scotia).
P. G. Wells.
In: Oil and Dispersants in Canadian Seas: Research Appraisal and Recommendations, EPS 3-EC-82-27, May 1982, Environmental Protection Service, Ottawa (Ontario). p 65-80, 2 Tab.

Descriptors: *Oil pollution, *Water pollution effects, *Zooplankton, *Marine animals, *Oil spills, *Toxicity, *Dispersants, *Ecological effects, Bioaccumulation, Plankton, Marine environment, Arctic, Crustaceans, Invertebrates, Environmental effects.

A considerable number of studies have been conducted on the toxicity of oils, dispersants, and chemically dispersed oils to marine zooplankton in Canadian waters. Collectively, these studies show the moderately to highly acute toxicity of naturally dispersed oil to various groups of zooplankton. Most of the 4-day LC50's, based on measured concentrations, range from 0.1 to 12 mg/L. Numerous adverse sublethal effects have been observed among oil-exposed zooplankton at concentrations < 1 mg/L (total measured hydrocarbons) for exposures varying from several days to weeks. Many important zooplankton have not yet been studied and among the species already tested various life stages and exposure conditions have not yet been investigated. No general relationship is known between threshold effect concentrations for key species and concentrations measured under chemically dispersed spills in Canadian waters. The effect of oil spills on zooplankton communities depends on the location, size, extent and duration of the spill. Further research is needed on the toxicology of dispersants and dispersed oil on key species to allow selection of dispersants for use on oil spills in Canadian marine waters. Additional studies should also be conducted on the bioaccumulation of spill pollutants and the recovery of key species exposed to dispersed oils.
W85-05587

EFFECTS OF OIL HYDROCARBONS AND DISPERSANTS ON FISH,
Department of Fisheries and Oceans, St. John's (Newfoundland). Biological Station.
W. R. Penrose.
In: Oil and Dispersants in Canadian Seas: Research Appraisal and Recommendations, EPS 3-EC-82-27, May 1982, Environmental Protection Service, Ottawa (Ontario). p 81-86, 1 Tab.

Descriptors: *Water pollution effects, *Dispersants, *Oil pollution, *Fish, *Bioaccumulation, *Fish behavior, *Oil, *Toxicity, Marine animals, Oil spills, Surface active agents, Fish physiology, Hydrocarbons, Aromatic hydrocarbons, Ecological effects.

Although numerous laboratory studies document the toxicity of oil and oil fractions to fish, little data has been recorded of significant fish kills caused by oil spills. Studies show that toxicity is more a function of the solubility of the oil tested than the fish species. Sublethal effects of oil on fish include responses that are difficult to monitor. Tainting of fish by petroleum hydrocarbons has frequently been recorded but the petroleum components responsible for tainting have not been identified. Many fractions of oil are readily taken up by fish. The mechanisms of toxicity are not well understood, although the aromatic hydrocarbons are suspected of disturbing the function of membranes. The aromatic constituents of oil are readily metabolized by the liver and some other organs. The toxicities of oil dispersants are not directly related to their effectiveness. At sublethal concentrations, oil-dispersant mixtures can affect swimming activity and equilibrium. Chemically dispersed oil is no more specifically toxic than undispersed oil. Areas of known spawning activity should not be subjected to dispersal treatment until more is known about the possible sublethal effects of oil dispersants.
W85-05588

BENTHIC AND INTERTIDAL ORGANISMS,
Department of Fisheries and Oceans, Ste. Anne de Bellevue (Quebec).
J. A. Percy.
In: Oil and Dispersants in Canadian Seas: Research Appraisal and Recommendations, EPS 3-EC-82-27, May 1982, Environmental Protection Service, Ottawa (Ontario). p 87-104.

Descriptors: *Water pollution effects, *Benthos, *Benthic fauna, *Benthic flora, *Invertebrates, *Oil pollution, *Dispersants, *Toxicity, Marine animals, Marine plants, Ecological effects, Benthic environment, Metabolism, Bioaccumulation, Salt marshes, Hydrocarbons, Oil spills, Oil.

Data on the effects of oil on benthic flora have largely been derived from field studies. Annuals are generally more susceptible than perennials. Moderate single-pollution incidents caused less damage to salt marsh vegetation than did successive or continuous low-level pollution by petroleum. Weathered crude is generally less toxic than fresh crude oil under laboratory conditions. Many species of marine benthic organisms dipurate hydrocarbons rapidly when transferred to clean seawater. Much research is being done on the biotransformation of hydrocarbons in marine animals. Subtidal invertebrates were generally more sensitive to petroleum than intertidal ones and larval stages were usually more susceptible than adults. Petroleum products have been shown to both stimulate and depress the metabolic rate of benthic invertebrates. Carcinogens found in crude oils can induce neoplastic growth and lesions in marine benthic organisms. Growth may prove a useful indicator of oil pollution stress in benthic organisms although benthic crustaceans vary in the degree to which their growth is impaired by exposure to oil in the laboratory. Little is known about the action of dispersants in facilitating oil entry into the substratum. The lethal effects of compounds present in dispersants on benthic crustacea have been evaluated. More research on the sublethal effects of dispersants on benthic organisms is needed before any broad generalization can be made.
W85-05589

BIRDS, OIL AND THE CANADIAN ENVIRONMENT,
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
R. G. Brown.
In: Oil and Dispersants in Canadian Seas: Research Appraisal and Recommendations, EPS 3-EC-82-27, May 1982, Environmental Protection Service, Ottawa (Ontario). p 105-112.

Descriptors: *Water pollution effects, *Oil pollution, *Oil slicks, *Oil spills, *Ecological effects, *Water birds, *Waterfowl, *Hatching, Marine environments, Birds, Eggs, Oily waters, Dispersants, Ducks, Gulls.

It is difficult to accurately estimate the number of birds killed by oil spills. Oil causes a matting of the feathers and derangement of the feather barbules which leads to the breakdown of waterproofing and insulation. Autopsies of oiled birds (mallard and scaup) show abnormal conditions of the lungs, pancreas, adrenals, nasal salt gland, gastrointestinal tract, kidneys, and liver and a reduced number of white blood corpuscles. Some evidence exists that oil exposure lowers the ability of birds to respond to other environmental stresses. There are conflicting claims about whether or not oil ingestion inhibits nutrient transfer across the intestinal wall. Crude oils with a high aromatic content have a narcotic effect on marine life which possibly inhibit their escape from oil slicks. Oil on egg surfaces reduces hatchability in many species of shore birds. The ingestion of crude oil reduces the growth rates of young Herring Gulls and Black Guillemots. Various methods could be tried to attract shore birds away from oil slicks, but the effectiveness of such techniques is still unknown. Oiled seabirds can be cleaned and rehabilitated, but only with difficulty and at a great expense.
W85-05590

EFFECTS OF OIL ON MARINE MAMMALS,
Institute of Ocean Sciences, Sidney (British Columbia).
B. D. Smiley.
In: Oil and Dispersants in Canadian Seas: Research Appraisal and Recommendations, EPS 3-EC-82-27, May 1982, Environmental Protection Service, Ottawa (Ontario). p 113-123.

Descriptors: *Water pollution effects, *Oil pollution, *Mammals, *Marine animals, *Toxicity, *Oil spills, *Oil slicks, *Animal behavior, Oily water, Hydrocarbons, Ecological effects, Seals, Dolphins, Whales, Behavior, Otters, Seals.

Sea mammals do not always avoid a floating oil slick or oil-stranded beach. Behavioral stimuli may overwhelm avoidance reactions. Contact fouling of mammals by heavy or weathered oil can cause sticking of appendages and plugged body opening of pinnipeds. Soiling and evaporation by light crude irritates eyes, nostrils and other mucous membranes of seals. Oil fouling of seals, otters and other fur/hair insulated mammals can cause chilling and hypothermia, loss of buoyancy, elevated metabolism, slowed growth rates, cessation of feeding and associated weight losses, increased solar heating of skin, and death. Pinnipeds can ingest oil when grooming, suckling or eating. Uptake of toxic hydrocarbon fractions by mammals is rapid but constitutes a reversible stress. Oil dispersants remove the natural skin oils of mammals and destroy the fur's water repellency. This is particularly dangerous to polar bears, sea otters, and fur seals who are buoyed by their body covering. Research on the oiling of sea mammals following oil spills is recommended due to the difficulties in oil experimentation using live sea mammals.
W85-05591

COMMUNITIES AND ECOSYSTEMS,
New Brunswick Univ., St. John. Dept. of Biology.
M. L. Thomas.
In: Oil and Dispersants in Canadian Seas: Research Appraisal and Recommendations, EPS 3-EC-82-27, May 1982, Environmental Protection Service, Ottawa (Ontario). p 125-134.

Descriptors: *Oil pollution, *Water pollution effects, *Salt marshes, *Ecosystems, *Oil spills, *Dispersants, *Marine animals, *Shores, Oil slicks, Marine environments, Fish, Species composition, Ecological effects, Environmental effects, Aquatic

habitats, Species diversity, Marine algae, Littoral environment, Intertidal areas, Littoral zone.

Research involving the effects of oil on marine communities and ecosystem is fairly recent. The magnitude and persistence of ecological effects on shoreline ecosystems depends on the amount of oil retained in the habitat. Disappearance rates vary with type of oil, climate, and weather conditions. Planktonic ecosystems vary in their response to oil depending on the species present and the type and concentration of the oil. Circumstantial evidence suggests that fish species composition and diversity of the stock may change in an oil spill area. Benthic communities show increases in opportunistic species in oiled sites and take several years to return to normal. Shoreline ecosystems are often devastated by oiling. In general, shore algae are quite resistent to oil pollution, while severe oil pollution causes either extensive mortality or narcosis to shore animals. Disappearance of grasses in salt marshes may cause accelerated erosion and habitat degradation. The use of dispersants for cleanup of oil on shorelines or in very sheltered or shallow bodies of water generally results in more extensive ecological disturbance than the oil alone. W85-05592

DIETARY ACCUMULATION OF PCBS FROM A CONTAMINATED SEDIMENT SOURCE BY A DEMERSAL FISH SPECIES (LEIOSTOMUS XANTHURUS),

Environmental Research Lab., Gulf Breeze, FL.
N. I. Rubinstein, W. T. Gilliam, and N. R. Gregory.

Technical Report D-84-6, November 1984. Final Report. US Army Long-Term Effects of Dreging Operations Program, Army Engineer Waterways Experiment Station, Vicksburg, MS. 25 p, 2 Fig, 4 Tab, 27 Ref.

Descriptors: *Accumulation, *Polychlorinated biphenyls, *Sediments, Pollutants, Fish, Leiostomus xanthurus, Food chains, Polychaetes, Harbors.

Accumulation and Dietary transfer of polychlorinated biphenyls (PCB's) from contaminated harbor sediments were studied in a laboratory food chain consisting of sediments, polychaetes (Nereis virens), and a predatory fish (Leiostomus xanthurus). The study conducted in two phases to distinguish dietary uptake from PCB accumulation resulting from sediment exposure alone. In Phase I, fish and polychaetes were separately exposed to field-collected PCB-contaminated sediments (5.2 microgram/g dry weight s Arocolor 1242 and 1254) in flow-through seawater systems for 40 days to allow organisms to approach steady-state concentrations. In Phase II, the dietary fraction of PCB accumulation was determined by selectively feeding exposed and control groups of fish polychaetes having a known PCB body burden. In addition, the effect of direct sediment contact on PCB accumulation by L. xanthurus was investigated. Results demonstrated that contaminated sediments can serve as a source of PCB's for uptake and trophic transfer in marine systems. Fish exposed to PCB-contaminate sediments and fed a daily diet of polychaetes from the same sediment accumulated more than twice the PCB whole-body residues than fish exposed to similar conditions but fed uncontaminated polychaetes. Following 20 days of feeding, the dietary contributed of PCBs accounted for 53% of the total body burden measured in fish, and this percentage appeared to be increasing. Results also indicated that fish isolated from a direct contact with PCB-contaminated sediment accumulate significantly lower PCB body burdens than fish allowed contact with sediment. W85-05600

STUDIES ON THE BOTTOM SEDIMENTS AND EPIPELIC ALGAE OF THE RIVER ELY, SOUTH WALES, U.K.,

University Coll., Cardiff (Wales). Dept. of Plant Science.
S. E. Antoine, R. T. Esho, and K. Benson-Evans.

Limnologica, Vol. 16, No. 1, p 1-7, September, 1984. 1 Fig, 3 Tab, 32 Ref.

Descriptors: *Bottom sediments, *Nutrients, *River Ely, *Wales, *Algae, Algal growth, River sediments, Epipelon, Aquatic plants, Organic matter, Wastewater pollution, Calcium, Phosphorus, Silica, Sodium, Potassium, Chlorophyll a.

The sediments and their associated epipelon of the River Ely were collected and studied for the first time during spring 1980. The organic matter content of the sediments was found to be affected by the amounts of both autochthonous and allochthonous organic matter supply. Treated sewage effluents contributed the allochthonous part of the organic load. The nutrient contents were closely correlated with the organic matter content. Phosphate values were found to exceed those of the nitrate since the former tend to be firmly adsorbed on the sediment particles whereas the latter is easily lost into the deeper sediment layers. Both phosphate and calcium contents were positively correlated. The silica content was mainly affected by the amounts of diatom frustules in the sediments. The low calcium content of the study area was attributed to the predominance of drift deposits in the underlying strata of the area. Calcium and magnesium were positively correlated with the organic matter content. The decomposition of dead epipelic algae and settled phytoplankton replenished some of the magnesium content of the sediment. Sodium and potassium were found in adequate supply. The epipelic algae were generally dominated by the diatoms. Highest organic matter appears most favorable for the growth of the blue green algae. The diatoms and the blue green algae were generally directly correlated with calcium and the green algae showed a reverse relationship with organic matter and calcium contents. Diatoms generally grew better on sediments with high silica content. Very high organic matter seemed not favorable for the growth of the Euglenophyta. Chlorophyll-a contents were closely correlated with the epipelic algal cell counts. Diatoms contributed most chlorophyll-a at two stations and the Euglenophyta at the other two. (Baker-IVI)
W85-05611

SEASONAL VARIATIONS OF DISSOLVED ORGANIC MATTER IN THE RIVER ELY, SOUTH WALES, U.K.,

University Coll., Cardiff (Wales). Dept. of Plant Science.
R. T. Esho, and K. Benson-Evans.

Limnologica (Berlin), Vol. 16, No. 1, p 9-14, September, 1984. 3 Fig, 2 Tab, 23 Ref.

Descriptors: *Seasonal variation, *River Ely, *Wales, *Dissolved solids, *Organic matter, Rivers, Temperature effects, Runoff, Wind, Water pollution effects, Phytoplankton, Wastewater pollution, Photosynthesis.

Seasonal variations of dissolved organic matter (DOM) in the River Ely were studied. The DOM showed local variations due to factors such as phytoplankton abundance, surface runoff, wind action and pollution at each station. Decay of sewage fungus complex at one of the sites also increased the organic load of that site. The absolute and average DOM values also showed seasonal variations at each station. The average values showed trimodal seasonal variations with maxima in October, January, and May, the latter being the highest, whereas the absolute values either showed a bimodal or trimodal seasonal distribution at the individual stations with the May maximum also being the highest at most stations. The October maximum was mainly due to the allochthonous organic matter. The highest phytoplankton populations, as indicated by the chlorophyll-a content, were obtained in May due to favorable environmental conditions for growth. Appreciable amounts of photosynthetic products liberated by the healthy planktonic algae in that month increased the DOM content. Higher temperatures in May and other suitable environmental conditions seemed to have accelerated the decomposition of coarse particulate organic matter in the stored detritus (allochthonous organic matter) and resulted in a considerable increase in the DOM content. The January peak was mainly related to land runoff after heavy rainfall and to a decrease in the rate of decomposition of organic matter during the considerable drop in water temperature. Increased mineralization of the oxidizable organic matter and dilution of the river water by rain and floods resulted in a decrease in the DOM or produced DOM fluctuations during the other months of the year. The amounts of dissolved oxygen were considerably lower than those of the total oxygen values in the months during which the higher DOM values were recorded. (Baker-IVI)
W85-05612

STUDIES ON THE BOTTOM SEDIMENTS OF AL-HAMMARA MARSH AREA IN SOUTHERN IRAQ,

University Coll., Cardiff (Wales). Dept. of Plant Science.
For primary bibliographic entry see Field 2L.
W85-05613

AMMONIFICATION AS AFFECTED BY THE OXYGEN LEVEL OF WATER,

Kalyani Univ. (India). Dept. of Zoology.
B. B. Jana, and S. K. Barat.

Limnologica (Berlin), Vol. 16, No. 1, p 67-70, September, 1984. 1 Fig, 2 Tab, 10 Ref.

Descriptors: *Ammonification, *Ponds, *Dissolved oxygen, *Water pollution effects, Dissolved oxygen, Mesotrophic lakes, Ammonia, Nitrogen, Bacteria.

A mesotrophic, freshwater fish pond was selected for measurement of ammonification rates. Measurements of ammonification rates in pond waters at various concentrations of dissolved oxygen revealed a significantly high rate under greater oxygen tension than under relatively low oxygen level. The intensive rate of ammonification in the former was confirmed by the dominance of ammonifiers. The rate of ammonification was highly correlated with the density of ammonifying bacteria. (Baker-IVI)
W85-05615

EFFECTS OF THE MARSEILLES' SEWAGE OUTFALL ON MEIOBENTHIC POPULATIONS (EFFETS DU DEVERSEMENT EN MER DU GRAND COLLECTEUR DE L'AGGLOMERATION MARSEILLAISE SUR LES POPULATIONS MEIOBENTHIQUES),

Centre Univ. de Luminy, Marseille (France). Lab. de Biologie des Invertebres Marins.
M. Keller.

Comptes Rendus Hebdomadaires des Seances Academie des Sciences, Paris, Vol. 299, Serie III, No. 19, p 765-768, December, 1984. 12 Ref.

Descriptors: *Wastewater pollution, *Marine environment, *Marine animals, *Marseilles, *France, Coastal waters, Domestic wastes, Species diversity, Water pollution effects.

The effect of an important marine pollution of domestic origin (Marseilles' sewage) on the structure of meiobenthic populations was studied. Several sectors can be pointed out: the coastal zone, very polluted, with a very poor meiofauna population but however present; the intermediate zone, polluted, relatively rich but containing a small number of species mainly tolerant; then the off-shore zone, less rich but with higher species diversity than the previous zone, under attenuated effects of the outfall. The decreasing pollution gradient from the sewage overflow to the off-shore zone is expressed, in the populations studied, by the increasing of both species diversity and Motomura's constant. (Author's abstract)
W85-05619

RELATIONSHIPS BETWEEN PHOSPHORUS LOADING AND TROPHIC STATE IN CALCAREOUS LAKES OF SOUTHEAST WISCONSIN,

Wisconsin Univ.-Madison. Water Chemistry Lab.
R. E. Stauffer.

Limnology and Oceanography, Vol. 30, No. 1, p 123-145, January, 1985. 1 Fig, 11 Tab, 96 Ref.

Descriptors: *Phosphorus, *Trophic state, *Calcareous lakes, *Wisconsin, Eutrophication, Chlo-

rophyll, Lake sediments, Pollution load, Mathematical models, Oligotrophic lakes, Eutrophic lakes.

The relationships among external phosphorus loading, lake phosphorus concentrations, and indices of lake trophic state are investigated for four calcareous and one noncalcareous lake in southeast Wisconsin. The total P and molybdate-reactive P concentrations during the winter and spring overturn are significantly higher in the calcareous lakes than predicted by models based on regional studies of Canadian Shield (ELA) lakes and the central New York Finger Lakes. The calcareous Wisconsin lakes have relatively low phosphorus retention coefficients and are eutrophic despite their low or only moderate external P loadings. By contrast, noncalcareous Devils Lake is oligotrophic; it is also adequately represented by the ELA loadings vs. response equations. The calcareous Wisconsin lakes and edaphically similar Lake Minnetonka, Minnesota, have lower epilimnetic chlorophyll concentrations in summer than predicted by the Dillon and Rigler equation (based on lake mean total P at spring overturn). Because these stratified lakes are frequently phosphorus-limited in midsummer, the failure of the Dillion-Rigler model may be related to seasonal cycles of mixed-layer concentrations of total P (and SRP) and also to the seasonal patterns of loading. These observations may be part of a larger edaphic pattern related to low phosphorus binding tendencies of certain calcareous lake sediments. (Author's abstract)
W85-05620

PHYSICAL, CHEMICAL, AND BIOLOGICAL CONSEQUENCES OF EPISODIC ALUMINUM ADDITIONS TO A STREAM,
Cornell Univ., Ithaca, NY. Section of Ecology and Systematics.
R. J. Hall, C. T. Driscoll, G. E. Likens, and J. M. Pratt.
Limnology and Oceanography, Vol. 30, No. 1, p 212-220, January, 1985. 3 Fig, 31 Ref.

Descriptors: *Snowmelt, *Aluminum, *Water pollution effects, Norris Brook, New Hampshire, Fate of pollutants, Streams, Acidity, Dissolved oxygen, Leaching, Hydrogen ion concentration, Organic carbon, Invertebrates, Drift.

To simulate an episodic increase during snowmelt, a stock solution of aluminum chloride (3.1 g Al/liter) was added to a second-order reach of Norris Brook in the Hubbard Brook Experimental Forest, New Hampshire. Experimental concentrations of aqueous Al were similar to those reported for acidic surface waters in the Adirondack Mountains of New York and for streams draining deforested watersheds in the White Mountains of New Hampshire. To simulate the pulsed input of Al leached from soil by daily snowmelt, a solution of AlCl3 was added at rates incremented hourly for 5 hr. Significant decreases in pH and dissolved organic carbon (DOC) and accumulation of foam at the surface accompanied a stepwise increase in Al in the water. In lab experiments added Al produced a 20% reduction in surface tension. The added Al may have associated with organic functional groups, rendering DOC more hydrophobic and less soluble. Some of these alumino-organic substances subsequently may have accumulated at the air-water interface. Terrestrial and aquatic invertebrate drift was also altered with elevated Al. Drift is attributed to responses to chemical changes in the stream such as Al and H(+) toxicity or to a physical change in surface film. (Baker-IVI)
W85-05621

EFFECT OF TEMPERATURE ON SURVIVAL OF CARP FRY, CYPRIUS CARPIO L., IN ACIDIC WATER,
Institute of Applied Biology, Siedlce (Poland).
M. Korwin-Kossakowski, and B. Jezierska.
Journal of Fish Biology, Vol. 26, No. 1, p 43-47, January, 1985. 2 Fig, 1 Tab, 19 Ref.

Descriptors: *Fish, *Survival, *Acidity, *Temperature effects, Dissolved oxygen, Respiration, Immature growth stages, Mortality.

An experiment was designed to determine the survival time of fry in water acidified to pH 4.1, at 18, 20, 24, 26, and 30 C, respectively. Carp fry mortality in water at pH 4.1 depended on temperatures. Within the temperature range of 18-26 C, the mortality was accelerated with an increase in temperature. However, at the temperature of 30 C, fish survived longer than at lower temperatures. At the temperatures studied the effect of a 26 hr accumulation period is beneficial. Carp fry obtained less oxygen in water at pH 4.0, as compared to pH 7.0. The differences, though insignificant, pointed to an adverse effect of acidification on the respiratory processes. (Baker-IVI)
W85-05623

CHANGES IN CLADOCERA COMMUNITY STRUCTURE AND FOSSIL PIGMENT STRATIGRAPHY AS COMPARED TO THE FIRE HISTORY OF ELK LAKE, CLEARWATER CO., MN, U.S.A.,
Indiana Univ. at Bloomington. Dept. of Biology.
D. S. Baas, and M. M. Boucherle.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1366-1371, December, 1984. 4 Fig, 20 Ref.

Descriptors: *Water pollution effects, *Fires, *Cladocera, *Elk Lake, *Minnesota, Fossils, Stratigraphy, Nutrients, Forest watersheds, Forest fires, Macrophytes.

Elk lake is located in Itasca State Park, Clearwater County, northwestern Minnesota. In a core dating back 30 years B.P., ten fires were identified based on charcoal evidence found in sediment samples. Effects of fire may be observed in samples containing evidence of fires. The Cladocera community changed fairly consistently in these samples. These changes concur with certain aspects of the fossil pigment stratigraphy. The two members of the planktonic Cladocera community, Bosmina longirostris and Daphnia longispina, together comprise over 80% of the total cladocerans throughout the core. At nearly all fires, littoral populations decrease relative to planktonic populations. This may represent decreased depth distribution of macrophytes resulting in a decrease in available habitat for littoral populations. This decrease in macrophytes may reflect a rise in turbidity due to increased erosional input of particulate matter, or an increase in phytoplankton resulting from nutrient influx. Pigment data exhibit somewhat variable results, but as in the Cladocera data, trends are noted. Increased sedimentary organic matter accompanied by a rise in pigment concentration indicates increased phytoplankton production. High levels of carbonates in the sediments may be indicative of either increased erosional inputs of terrestrial carbonates, or increased phytoplankton production resulting in in situ precipitation of carbonates. Fossil pigment diversity decreased in six samples containing evidence of fire. (Baker-IVI)
W85-05624

ACIDIFICATION HISTORY AND PREDICTION USING BIOLOGICAL INDICES,
Western Washington Univ., Bellingham. Inst. for Watershed Studies.
D. F. Brakke.
Verhandlung Internationale Vereinigung Limnologie, Vol. 2, No. 3, p 1391-1395, December, 1984. 4 Fig, 2 Tab, 18 Ref.

Descriptors: *Acidification, *Acid rain, *Lakes, *Water pollution effects, Diatoms, Cladocera, Prediction, History, Acidity, Water quality, Fish.

Changes in the chemistry of dilute freshwaters associated with acid precipitation have been reported from several areas. Diatom and cladocerans can be used to reconstruct the acidification history of lakes. The information produced on rate of pH change can be combined with steady state empirical models of acidification to predict lake water condition at specific times in the future. Given estimates of lakewater chemistry on a site or regional basis, empirical relationships can be used to predict fish status. Because the acidification model of Henriksen is driven by precipitation chemistry, various loading scenarios can be assessed in terms of fish population response. (Baker-IVI)
W85-05626

ANNUAL SEDIMENT ACCMULATION AND LAND USE HISTORY; INVESTIGATIONS OF VARVED LAKE SEDIMENTS,
Umea Univ. (Sweden). Dept. of Ecological Botany.
For primary bibliographic entry see Field 2J.
W85-05627

VARVE-DATED EUTROPHICATION HISTORY OF A SMALL LAKE,
Joensuu Univ. (Finland). Karelian Inst.
H. Simola, P. Huttunen, and J. Merilainen.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1404-1408, December, 1984. 3 Fig, 14 Ref.

Descriptors: *Lake Lankunlampi, *Finland, *Eutrophication, *Stratigraphy, *Varves, Diatoms, Chrysophyta, Lake sediments, Sedimentation, Sediments, Lakes, Pigments, History.

Lake Lankunlampi is situated in the rural district of Liperi in East Finland. The lake basin is a kettle-hole depression formed in a transverse ridge of glaciofluvial material. Microstratigraphy of diatoms and chrysophycean cysts was analyzed in tape peel preparations by 0.5 mm resolution in the sequence 0-30 cm, which was found to contain 68 varves. Sedimentary pigment concentrations were analyzed in 38 consecutive varves that were dissected from a freeze-dried sediment block. The sedimentary record of Lake Lankunlampi shows a rapid development of fairly eutrophic conditions. The human influence (mainly in the form of phosphate loading through the use of detergents and increased soil erosion) has been only weak or moderate all the time, but the effect appears cumulative, because the water exchange is very slow, mean annual rainfall being about 10% of the mean depth of the lake. The study clearly demonstrates the great sensitivity of this type of lake to even the mildest forms of human interference. (Baker-IVI)
W85-05628

AUTOMATED FISH RESPIRATORY MONITORING SYSTEM FOR STREAM ACIDIFICATION EPISODE ASSESSMENT,
Tennessee Technological Univ., Cookeville. Cumberland Biological Station.
For primary bibliographic entry see Field 5A.
W85-05629

EFFECTS OF URBAN STORMWATER RUNOFF ON RESERVOIR PHYTOPLANKTON,
George Mason Univ., Fairfax, VA. Dept. of Biology.
R. C. Jones, and G. W. Redfield.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1486-1492, December, 1984. 3 Fig, 3 Tab, 20 Ref.

Descriptors: *Urban runoff, *Storm runoff, *Reservoirs, *Phytoplankton, Suspended sediments, Heavy metals, Hydrocarbons, Water pollution effects.

The interactive effects of urban stormwater runoff are explored on a small recreational reservoir. Lab experiments and field observations are integrated to develop a conceptual model of the multiple interactions between urban stormwater and reservoir phytoplankton. A microcosm experiment in a small reservoir demonstrated that stormwater inflows can stimulate algal growth. Algal assays of stormwater found inhibition of growth due to heavy metals in runoff and isolated phosphorus as the limiting nutrient. Sediment laden stormwater lowered in situ primary productivity and other in lake measurements illustrated both the inhibitory and stimulatory influences of stormwater on lake phytoplankton. Urban runoff reduced light penetration, washed algae from the epilimnion, and inhibited productivity via heavy metals. The losses

of algal biomass are replaced by enhanced population growth rates and increasing densities as light increases, washout subsides, and imported nutrients are used. This cycle merits further research of underlying mechanisms and operation in other lakes, and is of management interest due to the ever-increasing stress of watershed urbanization. (Baker-IVI)
W85-05633

DEPENDENCE OF PHYTOPLANKTON ON ZOOPLANKTON IN A MAN-MADE LAKE,
Politechnika Slaska, Gliwice (Poland).
For primary bibliographic entry see Field 2H.
W85-05636

INFLUENCE OF EXPERIMENTAL ACIDIFICATION IN A LOTIC ENVIRONMENT OF THE BENTHIC INVERTEBRATE DRIFT (INFLUENCE D'UNE ACIDIFICATION EXPERIMENTALE EN MILIEU LOTIQUE SUR LA DERIVE DES INVERTEBRES BENTHIQUES),
Laval Univ., Quebec. Dept. de Biologie.
M. Allard, and G. Moreau.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1793-1800, December, 1984. 2 Fig, 2 Tab, 32 Ref.

Descriptors: *Acidification, *Invertebrates, *Benthic fauna, *Drift, *Aluminum, Hydrogen ion concentration, Streams, Mortality, Metals, Water pollution effects, Acidic water.

The effects of H(+) at different concentrations and of H(+) with aluminum on the intensity of drift, the faunistic composition and the mortality rate of the organisms of the drift were studied in an experimental channel. A colonization period of 64 days preceded the experimental acidification. Water was acidified using sulfuric acid to pH 3.5 and 4.0, and aluminum sulfate was added to water at pH 4.0 to produce a concentration of 0.2 mg/l. In the control channel, the average number of organisms in the drift for 24 hr was 1094 and the temporal variation was 14%. In the acidified channel the average number of drift organisms was approximately the same, 1074, but the temporal variation was greater (24%) and a maximum of 1499 organisms was observed 60 hr after the beginning of the acidification. With acidification plus the addition of aluminum, the average number of organisms was lower, 910, and the temporal variation was much greater (40%). A maximum of 1552 organisms was observed 60 hr after the start of exposure. A comparison of the rate of mortality in the drift and the substrates indicates that the increase in the drift is due to the passive entrainment of dead organisms, which is of minimal importance to the dynamics of benthic populations. (Moore-IVI)
W85-05660

FACTORS RELATED TO ALGAL BIOMASS IN MISSOURI OZARK STREAMS,
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W85-05667

RECENT DEVELOPMENTS OF THE PHYTOPLANKTON AND ITS ACTIVITY IN THE LOWER RHINE,
Landesamt fuer Wasser und Abfall Nordrhein-Westfalen, Dusseldorf (Germany, F.R.).
G. Friedrich, and M. Viehweg.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 2029-2035, December, 1984. 4 Fig, 13 Ref.

Descriptors: *Rhine River, *Germany (Federal Republic), *Netherlands, *Phytoplankton, Water pollution effects, Species composition, Population dynamics, Chlorophyll a, Diatoms, Chlorophyta, Eutrophication, Toxic inhibition.

Since 1979 the Lower Rhine has been investigated weekly with a biological program at 5 monitoring stations (4 in the Federal Republic of Germany and one where the Rhine runs to the Netherlands). Additional samples have been taken from a ship moving downstream with the flow. Parameters measured in the program have been phytoplankton (species composition and density), chlorophyll a and its activity expressed as oxygen production capacity. Centric diatoms dominate the plankton. Besides diatoms only chlorococcalian green algae are common. Phytoplankton standing comprises to 60,000 cells/ml, or 50 micro-g/liter chlorophyll a, with maxima regularly higher than 100 micro-g/liter. There is a direct correlation between chlorophyll, total radiation and flow. It is clear that the primary production in the Lower Rhine is limited by these abiotic conditions. There have been improvements in the general ecological situation of the Rhine in the last few years. A more detailed examination shows that the toxic inhibition, which has existed for 20 years, still exists on a lower level than before downstream from Dusseldorf. If this remaining inhibition disappears by improved sewage cleaning it can be expected that there will be increasing eutrophication in the Lower Rhine. (Baker-IVI)
W85-05683

BEHAVIOR OF CADMIUM IN SHORT-NECKED CLAM,
Chuo Univ., Tokyo (Japan). Dept. of Industrial Chemistry.
T. Ishii, T. Nishida, S. Midogohchi, T. Tokitake, and T. Kaneko.
Bulletin of the Japanese Society of Scientific Fisheries, Vol. 50, No 12, p 2055-2059, December, 1984. 7 Fig, 5 Tab, 8 Ref.

Descriptors: *Cadmium, *Clams, Heavy metals, Water pollution effects, Autoradiography, Cadmium radioisotopes, Sampling.

In order to obtain Cd-binding proteins in a concentrated form from mollusks, it is desirable to know in what organs in the body Cd is concentrated. Short-necked clams (Tapes japonica) were kept in sea water contained stable Cd and radioactive Cd-115m. The amount of Cd accumulated by a clam was measured with a NaI(Tl) scintillation counter one by one, without sacrificing the clam. The distribution of Cd in the body of a clam was determined by macroautoradiography. The accumulation of Cd by clams differs considerably from individual to individual. The amount of Cd in each clam scatters more as the period of Cd uptake becomes longer. As the period of Cd uptake becomes longer, the number of clams to be sampled must be gradually increased to estimate the amount of Cd with good accuracy. The main Cd-accumulating organ in clams is the Bojanus' organ; the mid-gut gland also accumulated Cd. (Moore-IVI)
W85-05686

OIL SPILL FISHERY IMPACT ASSESSMENT MODEL: SENSITIVITY TO SPILL LOCATION AND TIMING,
Rhode Island Univ., Kingston. Dept. of Ocean Engineering.
M. L. Spaulding, M. Reed, E. Anderson, T. Isaji, and J. C. Swanson.
Estuarine, Coastal and Shelf Science, Vol. 20, No. 1, p 41-53, January, 1985. 4 Fig, 3 Tab, 12 Ref. Dept. of the Interior contracts 14-12-0001-29154 and 14-12-0001-29181.

Descriptors: *Oil spills, *Marine fisheries, *Model studies, *Georges Bank, *Maine, Water pollution effects, Oil pollution, Simulation, Cod, Herring, Haddock, Spawning, Hydrodynamics.

An oil spill fishery impact assessment model system has been applied to the Georges Bank - Gulf of Maine region to assess the sensitivity of probable impact on several key fisheries to spill location and timing. Simulations of the impact on the fishery of tanker spills (20 million gallons released over 5 days), at two separate locations for each season of the year, and blowout spills (68 million gallons released over 30 days) at one location, with monthly releases and at six other locations with seasonal spills have been studied. Atlantic cod has been employed as the principal fish species throughout the simulations. Impacts on Atlantic herring and haddock have also been investigated for selected cases. All spill sites are located on Georges Bank with the majority in the general region of OCS (Outer Continental Shelf) leasing activity. The results of these simulations suggest a complex interaction among spill location and timing, the spatial and temporal distribution of spawning, the population dynamics of the species under study, and the hydrodynamics of the area. For the species studied, spills occurring during the winter and spring have the largest impact with cod being the most heavily impacted followed by haddock and herring. In all cases, the maximum cumulative loss to the fishery of a one time spill event never exceeded 25% of the annual catch with the exact value depending on the number of ichthyoplankton impacted by the spill and the compensatory dynamics of the population. (Author's abstract)
W85-05688

PHOSPHORUS CYCLING IN IONICALLY POLLUTED ONONDAGA LAKE, NEW YORK,
Upstate Freshwater Inst., Inc., Syracuse, NY.
For primary bibliographic entry see Field 5B.
W85-05690

MERCURY-INDUCED BLOOD ANOMALIES IN THE FRESHWATER TELEOST,
Kumaun Univ., Naini Tal (India). Dept. of Zoology.
T. S. Gill, and J. C. Pant.
Water, Air, and Soil Pollution, Vol. 24, No. 2, p 165-171, February, 1985. 10 Fig, 1 Tab, 14 Ref.

Descriptors: *Fish, *Mercury, *Toxicity, *Blood pathology, *Animal pathology, Heavy metals, Pathology, Water pollution effects, Chronic toxicity.

Experimental Hg poisoning in the fish, Barbus conchonius led to marked hematological anomalies. Acute exposure to 181 micro-g/L mercuric chloride (96 h LC50) led to erythrocytic anomalies including vacuolation, nuclear deterioration, microcytosis and collapsed cytoplasmic membranes. In addition, there was significant thrombocytosis and neutropenia together with a slight reduction in lymphocyte count. Chronic exposure to 36 and 60 micro-g/L mercuric chloride led to poikilocytosis, hypochromia, fragmentation and nuclear displacement in erythrocytes. The large lymphocytes revealed vacuolation, cellular and nuclear hypertrophy and cytoplasmic outgrowths. Thrombocytosis, lymphocytosis, neutropenia and mild basophilia were manifested in fish subjected to chronic poisoning. (Author's abstract)
W85-05692

NICKEL INDUCED HYPERGLYCEMIA IN THE FRESHWATER FISH, COLISA FASCIATUS,
Gorakhpur Univ. (India). Dept. of Zoology.
H. S. Chaudhry, and K. Nath.
Water, Air, and Soil Pollution, Vol. 24, No. 2, p 173-176, February, 1985. 1 Tab, 38 Ref.

Descriptors: *Hyperglycemia, *Fish, *Nickel, *Toxicity, Water pollution effects, Fish behavior, Blood, Stress.

Blood glucose has been reported as a reliable and sensitive indicator of environmental stress in fish. The effect of nickel sulfate at a sublethal dose (64 ppm - 0.8 of LC50 96 hr) on the blood glucose levels of the freshwater fish, Colisa fasciatus, was studied over a period of 96 hr. After exposure to Ni the fish became restless, coming to the surface of the water every 2 to 3 minutes. The toxic reaction also resulted in the formation of a mucus layer at the opercular region. The blood glucose level exhibits a steady increase due to Ni toxicity. A maximum increase of 85.08% is observed at 96 hr ($P < 0.001$). The hyperglycemia in C. fasciatus, caused by exposure to nickel sulfate, is possibly a reflection of stress-induced hormone mediated response. The blood glucose level may be a reliable indicator of Ni toxicity to fish. (Moore-IVI)
W85-05693

EFFECT OF THE CARBAMATE PESTICIDE SEVIN ON THE INTESTINAL ABSORPTION OF SOME NUTRIENTS IN THE TELEOST FISH, CHANNA PUNCTATUS,
D.A.V. Coll., Muzaffarnager (India). Dept. of Zoology.
K. V. Sastry, and A. A. Siddiqui.
Water, Air, and Soil Pollution, Vol. 24, No. 3, p 247-252, March, 1985. 4 Tab, 40 Ref.

Descriptors: *Fish, *Pesticide toxicity, *Sevin, Intestinal absorption, Carbamate pesticides, Toxicity, Digestive system, Nutrition.

The effect of four concentrations (0.1, 1, 10 and 100 ppm) of Sevin on the rate of uptake of two sugars (glucose and fructose) and an aminoacid (tryptophan) by the intestine of the fresh water snake-head fish, Channa punctatus has been investigated. All four concentrations of the pesticide decreased the rate of transport of the three nutrients. No direct relationship could be established between the concentration of Sevin in the medium and decrease in the rate of transport of nutrients, although increase in the concentration of Sevin reduced the absorption of nutrients by the intestine to a greater extent. Experiments conducted in vivo and in vitro showed that in both cases the pesticide decreased the brush border enzyme activity. (Author's abstract)
W85-05697

INTEGRATED USE OF PHYSICAL AND MATHEMATICAL MODELS TO EVALUATE ECOLOGICAL EFFECTS,
State Univ. of New York Coll. at Plattsburgh. Center for Earth and Environmental Science.
J. L. Malanchuk, and H. P. Kollig.
Water, Air, and Soil Pollution, Vol. 24, No. 3, p 267-281, March, 1985. 5 Fig, 4 Tab, 16 Ref.

Descriptors: *Cycling nutrients, *Model studies, *Mathematical models, *Water pollution effects, Simulation, Nutrients.

Nutrient cycling is of central importance in the health and maintenance of all ecosystems, thus it is argued that greater emphasis be placed on the impact of hazardous materials on nutrient cycling. To investigate this concern, flowthrough aquatic microcosms were used in conjunction with a simple, multi-element, mathematical model to initiate the development of a large scale model capable of predicting the effects of xenobiotics on ecosystem nutrient cycling. Potential toxicant effects were imposed on the model to determine whether changes in dissolved nutrient concentrations could be noted. Simulation results demonstrated that toxicant effects on dissolved nutrient concentrations were observable. The model also was employed to study the effect of different aufwuchs C:N:P ratios on dissolved nutrient concentrations. Although experimental data indicated that the aufwuchs C:N:P ratio was not constant, the use of constant stoichiometry in the model did not alter its utility. (Author's abstract)
W85-05699

TEMPORAL RESPONSES OF THE MACROPHYTE, POTAMOGETON PERFOLIATUS L., AND ITS ASSOCIATED AUTOTROPHIC COMMUNITY TO ATRAZINE EXPOSURE IN ESTUARINE MICROCOSMS,
Maryland Univ., Cambridge. Horn Point Environmental Labs.
J. J. Cunningham, W. M. Kemp, M. R. Lewis, and J. C. Stevenson.
Estuaries, Vol. 7, No. 4B, p 519-530, December, 1984. 6 Fig, 2 Tab, 61 Ref. EPA grant R805932010.

Descriptors: *Atrazine, *Potamogeton, *Estuarine environment, *Chesapeake Bay, *Water pollution effects, Macrophytes, Phytotoxicity, Herbicides, Aquatic plants, Biomass, Chlorophyll a.

Effects of the herbicide, atrazine, on the submersed vascular plant, Potamogeton perfoliatus, were monitored for 4 wk in 700 L microcosms containing water, sediments and plants from upper Chesapeake Bay. Two atrazine treatments (plus controls) were employed in duplicate systems, with water column concentrations averaging about 0.13 and 1.20 micro-g/L, respectively. Atrazine concentrations at low dose were in the range of the highest values reported in Chesapeake Bay, and significant decreases in apparent O2 production (Pa) of P. perfoliatus were observed immediately following treatment. However, significant recovery of Pa was evident at low dose within 2 wk, even though atrazine levels remained relatively constant. At the higher atrazine treatment, phytotoxic effects were even more pronounced, with no recovery occurring during the study period. Integrated community production and consumption of O2 followed patterns similar to those for P. perfoliatus alone, with some minor increases in relative contributions of other autotrophic groups (phytoplankton, epiphytes, benthic microalgae). While areal densities of plant shoots for the experimental populations were unaffected by the lower treatment, total biomass decreased significantly, lagging 2-4 wk after the initial decrease in Pa. Morphology of individual shoots was markedly influenced by atrazine, with significant increases in mean shoot length and decreases in weight per unit length. Furthermore, chlorophyll a content of leaves increased 5-fold with atrazine treatment. These effects are similar to previously reported shade adaptations of this and other submersed plants. (Author's abstract)
W85-05708

DISTRIBUTION AND ABUNDANCE OF SUBMERGED AQUATIC VEGETATION IN CHESAPEAKE BAY: AN HISTORICAL PERSPECTIVE,
Virginia Inst. of Marine Science, Gloucester Point.
R. J. Orth, and K. A. Moore.
Estuaries, Vol. 7, No. 4B, p 531-540, December, 1984. 6 Fig, 39 Ref. EPA grants R805951, X003201 and X003246.

Descriptors: *Submerged plants, *Distribution, *Abundance, *Chesapeake Bay, *History, Eelgrass, Watermilfoil, Water pollution effects, Eutrophication, Turbidity, Tropical storms, Aquatic plants.

An historical summary of the distribution and abundance of submerged aquatic vegetation (SAV) in the Chesapeake Bay is presented. Evidence suggests that SAV has generally been common throughout the bay over the last several hundred years with several fluctuations in abundance. The decline of Zostera marina (eelgrass) in the late 1930's and the rapid expansion of Myriophyllum spicatum (watermilfoil) in the late 1950's and early 1960's were two significant events involving a single species. Since 1965, however, there has been a significant reduction of all species in most sections of the bay. Declines were first observed in the Patuxent, Potomac and sections of other rivers in the Maryland portion of the Bay between 1965 and 1970. Dramatic reductions were observed over the entire length of the bay from 1970 to 1975. Particularly severe losses were observed at the head of the bay around Susquehanna Flats as well as in numerous rivers along Maryland's eastern and western shores. Changes in the lower, Virginia portion of the bay occurred primarily in the western tributaries. Greatest losses of vegetation occurred in the years following Tropical Storm Agnes in 1972. Since 1975 little regrowth has been observed in the Chesapeake Bay. Other areas along the Atlantic Coast of the U.S. during the same period have experienced no similar widespread decline. It thus appears that the factors affecting the recent changes in distribution and abundance of submerged vegetation in the bay are regional (related to the bay) in nature. Causes for this decline may be related to changes in water quality, primarily increased eutrophication and turbidity. (Author's abstract)
W85-05709

FERTILIZATION SUCCESS AND SPERM MOTILITY OF ATLANTIC SALMON (SALMO SALAR L.) IN ACIDIFIED WATER,
Department of Fisheries and Oceans, St. Andrews (New Brunswick). Biological Station.
P. G. Daye, and B. D. Glebe.
Aquaculture, Vol 43, No. 1/3, p 307-312, December, 1984. 2 Fig, 22 Ref.

Descriptors: *Salmon, *Reproduction, *Acidic water, *Water pollution effects, Hydrogen ion concentration, Fish fertilization.

Fertilization success of Atlantic salmon, Salmo salar, eggs by large sea-run males and precocious male parr in acidic water (pH 6.8-3.4) was determined. There was no effect on fertilization success at pH 5.0 or above. Fertilization success did decline from pH 5.0 to 4.0. No eggs were fertilized in tests below pH 4.0. The pH LL50 was 4.5 for fertilization success. Duration of spermatozoan motility constantly declined at all tested levels until about pH 4.5 where the decline became extremely rapid with no motility occurring near pH 4.0. The duration of spermatozoan motility of precocious male parr was longer than that for the large sea-run males at pH levels about 4.4. The recruitment of young Atlantic salmon into fish populations in acid stressed waters is reduced at pH levels below 5.0. In waters of pH 4.5 and below, Atlantic salmon populations probably do not exist. (Author's abstract)
W85-05712

EFFECTS OF SEWAGE POLLUTION ON CORAL-REEF COMMUNITIES,
Tetra Tech, Inc., Bellevue, WA.
R. A. Pastorak, and G. R. Bilyard.
Marine Ecology - Progress Series, Vol. 21, No. 1-2, p 175-189, January, 1985. 4 Fig, 3 Tab, 112 Ref.

Descriptors: *Wastewater pollution, *Coral reefs, *Water pollution effects, Marine environment, Lagoons, Nutrients, Sediments, Algae, Primary productivity, Invertebrates, Particulate matter, Corals, Toxicity.

Sewage pollution is an increasing problem in tropical marine environments. In this review, present knowledge of the effects of sewage pollution on coral-reef communities is synthesized and directions are suggested for future research. A wide range of sewage impacts on coral-reef communities has been reported. Little or no impact has been observed on some reefs in well-flushed waters that receive small quantities of effluent, whereas large discharges of effluent into poorly-flushed lagoons and bays have caused major changes in species composition and abundance. The 3 components of sewage effluent most detrimental to coral communities are nutrients, sediments, and toxic substances. Nutrient enrichment by sewage effluent may enhance benthic algal biomass and primary production in the water column. Increased primary production in the water column favors benthic filter-feeding invertebrates which, with the benthic algae, may out-compete corals and other reef-building organisms. Anthropogenic inputs of dissolved nutrients and organic particulate matter may also depress oxygen levels. While heavy sediment loads on corals may be lethal, lesser quantities may inhibit growth, cause changes in the growth forms of colonies, decrease coral cover, alter species composition of reef-building organisms, and inhibit coral recruitment. Toxic substances may induce metabolic changes in corals, decrease rates of growth and reproduction, or reduce viability of corals. Although further research is needed on all three major components of sewage effluent, the most critical need is for comprehensive, long-term studies of sewage impacts. The combined effects of particulate and toxic substances are especially poorly documented at this time. (Author's abstract)
W85-05714

ELEVATED PLANKTONIC ROTIFER BIOMASS IN ACIDIFIED METAL-CONTAMINATED LAKES NEAR SUDBURY, ONTARIO,
Ontario Ministry of the Environment, Dorchester. Dorset Research Center.
N. D. Yan, and W. Geiling.
Hydrobiologia, Vol. 120, No. 3, p 199-205, January, 1985. 1 Fig, 3 Tab, 34 Ref.

Descriptors: *Rotifers, *Crustaceans, *Biomass, *Clearwater Lake, *Swan Lake, *Ontario, Trace metals, Acid lakes, Water pollution effects, Zooplankton.

Planktonic rotifer biomass and abundance in two trace metal-contaminated, acidified lakes (Clearwater and Swan Lakes) were compared with that of six non-acidic lakes in central Ontario which had low levels of metals. Swan and Clearwater Lakes have been severely impacted by the smelting of sulfide ores by industries in the Sudbury area. Eighteen taxa of rotifers were identified in Swan and Clearwater Lakes. Keratella taurocephala was the most important rotifer species. It occurred in all samples and formed 80-95% of the average rotifer biomass in Clearwater Lake and 77% in Swan Lake. Total (rotifer plus crustacean) zooplankton biomass was greater in the non-acidic lakes (33-93 mg/cu m dry weight) than in the acidified lakes (9-29 mg/cu m), because of greater crustacean zooplankton biomass. Rotifer biomass was much greater in the acidified lakes (averaging 6.0 mg/cu m) than in the non-acidic lakes where it averaged only 0.5 mg/cu m. Rotifers formed 16-51% of the total zooplankton biomass in the acidified lakes but only 0.5-1.3% of the total in the non-acidic lakes. The great abundance of rotifers in the acidic lakes may be attributable to a reduction in densities of crustacean competitors. (Moore-IVI)
W85-05715

AUTECOLOGY OF CYATHURA CARINATA (CRUSTACEA : ISOPODA) IN A COOLING WATER DISCHARGE LAGOON,
Central Electricity Generating Board, Southampton (England). Marine Biological Lab.
R. N. Bamber.
Journal of the Marine Biology Association, Vol. 65, No. 1, p 181-194, February, 1985. 8 Fig, 2 Tab, 23 Ref.

Descriptors: *Isopods, *Thermal pollution, *River Medway, *England, Habitat, Cooling water, Lagoons, Water temperature, Effluents, Reproduction, Growth.

A population of Cyathura carinata living in the thermal effluent outfall lagoon of Kingsnorth Power Station, River Medway, Kent, England was studied from monthly samples over 33 months. The habitat was a coarse muddy sand substrate, in an enhanced temperature regime ranging from a minimum of 13 C in January to a maximum of 27 to 30 C in August. The population shows recruitment from May to August, winter growth, and no growth during the breeding season, with a 3 year life span, high female bias in the 1 + sex ratio, and almost all 2 + individuals are male. Production reflects growth in size, amounting to an annual production of 750 mg/sq m. The number of embryos in a brood ranged from 14 to 45 (mean 29.8) with no detectable brood mortality; embryo size is not influenced by brood number of female size, but brood number is related to the length of the female. It is concluded that a 3rd year of life, low numbers of 1 + males and protogynous hermaphroditism are advantageous strategies for northern (colder water) populations of C. carinata. From evolutionary characteristics the Kingsnorth lagoon supports a northern population which, in the enhanced temperature regime of the outfall water, achieves growth rates and a breeding cycle typical of a southern population. (Author's abstract)
W85-05719

IMPACT OF A MASSIVE DOMESTIC POLLUTION ON THE BIOLOGY AND MORPHOMETRY OF THE ECHINOID PARACENTROTUS LIVIDUS: PRELIMINARY DATA (IMPACT DE LA POLLUTION DOMESTIQUE SUR LA BIOLOGIE ET LA MORPHOMETRIE DE L'ECHINOIDE PARACENTROTUS LIVIDUS (LAMARCK). DONNEES PRELIMINAIRES),
Aix-Marseille-3 Univ. (France). Lab. de Zoologie Marine.
P. Delmas, and M.-B. Regis.
Comptes Rendus Hebdomadaires des Seances, Academie des Sciences, Paris, Vol. 300, Serie III, No. 4, p 143-146, 1985. 1 Fig, 1 Tab, 12 Ref.

Descriptors: *Water pollution effects, *Wastewater pollution, *Sea urchins, *Marseilles, *France, Marine environment, Organic matter, Growth, Mortality.

Paracentrotus lividus populations, within the plume generated by the Marseilles (France) conurbation outlet, display along the seashore a decreasing gradient of domestic pollution from E to W. The density of populations tends to increase in proportion as it gets nearer the discharge point. In the two nearest stations investigated (500 and 1,200 m) from the outlet, the average size of the sea-urchin is reduced and the test diameter usually does not exceed 30 mm; by contrast the spine-length enlarges up to about half of test diameter. This lengthening may be considered as a morpho-functional adaptation to a more active and efficient taking up of the plentiful organic material - dissolved and chiefly suspended - existing in the water column. Thanks to this adaptative strategy this sea-urchin not only is able to live within such a highly polluted environment but also to flourish therein. The smaller average size of the specimens in the two stations closest to outlet must be ascribed either to the early mortality of subadult and adult individuals, or to a case of dwarfing, like the population which formerly lived in the brackish water Berre lagoon. (Author's abstract)
W85-05723

LONGTERM STUDIES ON ALKALINE PHOSPHATASE ACTIVITY (APA) IN A LAKE WITH FISH-AQUACULTURE IN RELATION TO LAKE EUTROPHICATION AND PHOSPHORUS CYCLE,
Warsaw Univ. (Poland). Dept. of Environmental Microbiology.
R. J. Chrost, W. Siuda, and G. Z. Halemejko.
Archiv fur Hydrobiologie, Supplement 70, No. 1, p 1-32, December, 1984. 11 Fig, 3 Tab, 81 Ref.

Descriptors: *Alkaline phosphatase, *Aquaculture, *Phosphorus, *Eutrophication, *Lake Glebokie, *Poland, Cycling nutrients, Phytoplankton, Bacteria, Trout, Water pollution effects.

The alkaline phosphatase activity (APA) of microplankton from the photic and profundal zones of Lake Glebokie (Poland) was studied in relation to the P cycle and eutrophication from intensive rainbow trout culture. APA was measurable throughout the study period and fluctuated considerable from month to month. Higher APA was found in the photic zone than in the profundal zone of the lake. Phytoplankton blooms increased APA. The highest specific APA in the photic zone was observed during the summer stagnation; it corresponded well to the lowest concentration of dissolved inorganic P (DIP). The relationship between APA and DIP in the photic zone was an inverse non-linear function. Alkaline phosphatase in the photic zone had an inductive property, while in the profundal zone of the lake is was constitutive in nature. The contribution of phytoplankton and bacteria to APA, and P-32 PO4(-3) uptake, showed that bacteria are superior competitors for orthophosphate in lake waters. APA is an important source of internal DIP loading for the lake. The rapid eutrophication of Lake Glebokie is apparently due to the intensive cultivation of trout by live-box culture. (Moore-IVI)
W85-05726

TOXICITY OF COPPER TO THE MARINE BACTERIUM VIBRIO ALGINOLYTICUS,
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
D. R. Schreiber, A. S. Gordon, and F. J. Millero.
Canadian Journal of Microbiology, Vol. 31, No. 1, p 83-87, January, 1985. 7 Fig, 1 Tab, 26 Ref. ONR grant N00014-80-C-0042 and NSF grant GA40532.

Descriptors: *Copper, *Marine bacteria, *Vibrio, Toxicity, Heavy metals, Anaerobic conditions, Aerobic conditions, Toxicity, Cytostatic, Water pollution effects, Organic compounds.

The toxicity of copper to the marine bacterium Vibrio alginolyticus was examined. Experiments were conducted with both aerobic and anaerobic cultures. Calorimetric and radiochemical techniques were used to examine the effect of copper on heat production, respiration, and carbon assimilation by the cultures. Plate counts were used to determine the number of viable cells present. Copper was more toxic to the bacterium in anaerobic culture (mean toxic concentration (TC50) = 2.1 micro-M) than in aerobic culture (TC50 = 6.4 micro-M). Both cytotoxic and cytostatic effects were observed. The cytotoxic effect was not significantly different under aerobic and anaerobic conditions. The cytostatic effect, observed only in anaerobic culture, resulted in a decrease in the rate of metabolism of the surviving cells. The magnitude of the cytostatic and cytotoxic effects were dependent on the copper concentration, exhibiting saturation at higher concentrations. Organic chelators EDTA and nitrilotriacetic acid protected the anaerobic cultures from the copper, indicating that Cu-organic complexes are not toxic to the organism. (Author's abstract)
W85-05743

RELATIONSHIP BETWEEN THE GROWTH OF ALGAE AND AQUATIC MACROPHYTES IN BRACKISH WATER,
Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
W. Van Vierssen, and T. C. Prins.
Aquatic Botany, Vol. 21, No. 2, p 165-179, February, 1985. 4 Fig, 5 Tab, 36 Ref.

Descriptors: *Brackish water, *Algae, *Macrophytes, *Plant growth, Eutrophication, Aquatic plants, Allelopathy, Anabaena, Zannichellia.

Many brackish-water ecosystems in coastal areas of western Europe are being threatened by severe eutrophication and algal blooms. Eutrophication causes a decline in aquatic macrophytes and as a result, a decline in the associated animal communities. The decline in macrophytes may be a result of the growth inhibition of aquatic macrophytes by algae by means of allelopathy. Allelopathic interactions between the growth of planktonic algae and the growth of aquatic macrophytes were studied under experimental conditions. Addition of algal filtrate to cultures of the macrophyte Zannichellia peltata had a clearly negative effect on the net oxygen production of this macrophyte. The algal culture mainly consisted of Anabaena. The number of algal cells and the biomass of the aquatic macrophytes in the experiments were of the same order of magnitude as in the field. The release of allelopathic substances by certain algae may play an important role in macrophyte decline under eutrophic conditions. (Moore-IVI)
W85-05744

COMBINED EFFECT OF SALINITY AND TRIETHYL STANNIC CHLORIDE ON THE DEVELOPMENT OF THE MARINE FORMS OF THREE-SPINE STICKLEBACK, GASTEROSTEUS ACULEATUS (GASTEROSTEIDAE),
Moscow State Univ. (USSR). Dept. of Biology.
S. G. Soin, O. P. Danil'chenko, and A. S. Khandal.
Journal of Ichthyology, Vol. 24, No. 4, p 26-34, 1984. 4 Tab, 6 Ref. Translated from Voprosy Ikhtiologii, No. 3, p 481-489, 1984.

Descriptors: *Stickleback, *Salinity, *Triethyl stannic chloride, *Development, Toxicity, Mortality, Pathology, Embryonic growth stage.

The development of the marine form of three-spine stickleback, Gasterosteus aculeatus, were studied in freshwater and in water with 25 and 5 0/00 salt content, as well as at each of these salinity levels with triethyl stannic chloride solutions at the concentrations of 0.000001 - 10 mg/liter. The morphological changes in the embryos and prolarvae, their survival, heart beat and extent of development of the individual body parts were investigated. The stickleback develops normally in freshwater, showing a tendency for a slight reduction in growth and some irregularity in heart beat. Triethyl stannic chloride (TESC) manifested similar toxicity as in the case of freshwater bonyfishes which is expressed in the level of lethal concentrations and in stoppage of development at the morula stage. On the whole, the stickleback was found to be less resistant to the TESC action than other teleost fishes previously studied. With simultaneous action of reduced salinity and TESC, the intensity of

development increases with decreased salinity. (Author's abstract)
W85-05750

EFFECT OF HARMFUL FACTORS ON THE POSTTRAUMATIC MITOTIC ACTIVITY IN THE LENS EPITHELIUM OF RAINBOW TROUT, SALMO GAIRDNERI (SALMONIDAE),
Vsesoyuznyi Zaochnyi Inst. Pishchevoi Promyshlennosti, Moscow (USSR).
Y. G. Simakov.
Journal of Ichthyology, Vol. 24, No. 4, p 35-39, 1984. 12 Ref. Translated from Voprosy Ikhtiologii, No. 3, p 490-494, 1984.

Descriptors: *Trout, *Mitotic activity, *Toxicity, *Lens epithelium, Eye, Traumatization, Water pollution effects, Dibutyl sebacyanate, Polyterpenes, Aminopropyl triethoxysilane.

In the natural environment, fish are rarely exposed to the action of a single unfavorable factor. Traumatization can stimulate mitotic activity and make the organism more vulnerable to pollutants. To study the effect of trauma and toxicants in acute and chronic experiments, the lens epithelium can be a very convenient tissue, as it constantly undergoes mitotic division and is a regular single-layer cellular structure. The effects of dibutyl sebacyanate, polyterpenes and aminopropyl triethoxysilane (AMG-9) were studied in chronic experiments on the posttraumatic mitotic activity of the lens epithelium of rainbow trout, Salmo gairdneri. Tributyl sebacyanate and polyterpenes act as mitotic inhibitors at concentrations of 10 and 0.1 mg/liter, while AGM-9 stimulates mitotic activity. Two days before the termination of the experiment, the lens epithelium was traumatized by being pricked with a needle. Traumatization of the lens leads to a higher mitotic index in the germinative zone of epithelium. The combined effect of a substance stimulation mitotic division and traumatization increases the mitotic index in the germinative zone more than two-fold as compared to controls. (Moore-IVI)
W85-05751

USE OF LARGE ENCLOSURES FOR PERTURBATION EXPERIMENTS IN LENTIC ECOSYSTEMS: A REVIEW,
Wyoming Water Research Center, Laramie.
F. S. Sanders.
Environmental Monitoring and Assessment, Vol. 5, No. 1, p 55-99, March, 1985. 2 Fig, 6 Tab, 151 Ref. Electric Power Research Institute contract RP 1822-6.

Descriptors: *Water pollution effects, *Ecosystems, *Enclosure studies, Toxicity, Lentic environment, Marine environment.

A fundamental goal of aquatic ecotoxicology is the prevention of undesirable ecological change resulting from release of effluents into surface waters. Field enclosure studies provide an experimental bridge between laboratory test systems and natural ecosystems. Literature on use of field enclosures in freshwater and marine systems is reviewed to assess how accurately enclosures mimic ecological conditions and process rates occurring in adjacent open habitat. Among- and within-replicate variability of ecological parameters in field enclosures is compared to those in laboratory microcosms and open field habitat respectively. Studies using field enclosures can provide defensible data at the population and community levels over time periods of several months and spatial scales of tens of meters. The degree of ecological realism that can be achieved is variable. Chronic effects of some pollutants may be difficult to separate from nonspecific effects due to enclosure. Physical separation of part of a natural habitat from its surroundings produces a set of artificial stresses that affect the enclosed system's behavior before and during the application of a toxicant stress. Enclosure experimentation, together with supplemental laboratory studies, will significantly aid in establishing causality in impact relationships observed in the open field. Field enclosures are especially suited for the evaluation of the persistence of toxicity. (Moore-IVI)
W85-05764

QUANTITATIVE STRUCTURE-ACTIVITY RELATIONSHIPS AND MIXTURE TOXICITY OF ORGANIC CHEMICALS IN PHOTOBACTERIUM PHOSPHOREUM: THE MICROTOX TEST,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Veterinary Pharmacology, Pharmacy and Toxicology.
J. Hermens, F. Busser, P. Leeuwangh, and A. Musch.
Ecotoxicology and Environmental Safety, Vol. 9, No. 1, p 17-25, February, 1985. 2 Fig, 7 Tab, 24 Ref.

Descriptors: *Toxicity, *Bacteria, *Photobacterium, *Organic chemicals, *Microtox test, *Bioassays, Bioluminescence, Partition coefficient, Water pollution effects.

Quantitative structure-activity relationships were calculated for the inhibition of bioluminescence of Photobacterium phosphoreum by 22 nonreactive organic chemicals. The inhibition was measured using the Microtox test and correlated with the partition coefficient between n-octanol and water (P sub oct), molar refractivity (MR), and molar volume (MW/d). At log P sub oct < 1 and > 3, deviations from linearity were observed. Introduction of MR and MW/d improved the quality of the relationships. The influences of MR or MW/d may be related with an interaction of the tested chemicals to the enzyme system which produces the light emission. The sensitivity of the Microtox test to the 22 tested compounds is comparable to a 14-day acute mortality test with guppies for chemicals with log P sub oct < 4. The inhibition of bioluminescence by a mixture of the tested compounds was slightly less than was expected in case of concentration addition. The Microtox test can give a good estimate of the total aspecific 'minimum toxicity' of polluted waters. When rather lipophilic compounds or pollutants with more specific modes of action are present, this test will underestimate the toxicity to other aquatic life. (Author's abstract)
W85-05809

USE OF COHORTS AND POPULATIONS IN CHRONIC TOXICITY STUDIES WITH DAPHNIA MAGNA: A CADMIUM EXAMPLE,
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands). Lab. for Ecotoxicology.
C. J. van Leeuwen, W. J. Luttmer, and P. S. Griffioen.
Ecotoxicology and Environmental Safety, Vol. 9, No. 1, p 26-39, February, 1985. 7 Fig, 4 Tab, 39 Ref.

Descriptors: *Toxicity, *Daphnia, *Cadmium, *Heavy metals, Crustaceans, Water pollution effects, Water quality standards, Ecological effects.

Two semistatic life table experiments with Daphnia magna were carried out on reconstituted and Lake IJssel water. The 'nontoxic concentrations' for cadmium with respect to the intrinsic rate of natural increase, derived from age-specific survival and fecundity were 1 and 3.2 micro g/liter, respectively. Body length appeared to be a sensitive parameter. A third intermittent-flow experiment was started with small, exponentially growing populations. These populations had a stable age distribution, were composed of cohorts of different ages and showed an almost perfect logistic growth. Cadmium was shown to reduce the upper numerical limit (carrying capacity) for D. magna and was inversely related to this parameter: log $Y = 2.85 - 0.20$ log(concentration of Cd); $r = -0.99$. A 'nontoxic concentration' could not be established. Based on the 'background' concentration of cadmium, a freshwater quality criterion of 0.1 micro g/liter was proposed. The results indicate several shortcomings of the current methods. Introduction of the concepts of population dynamics in reproduction tests with D. magna is a realistic step towards ecotoxicology. (Collier-IVI)
W85-05810

TOXIC IMPACT OF EFFLUENTS FROM PETROCHEMICAL INDUSTRY,
National Board of Waters, Helsinki (Finland).
E. Nikunen.
Ecotoxicology and Environmental Safety, Vol. 9, No. 1, p 84-91, February, 1985. 1 Fig, 4 Tab, 16 Ref.

Descriptors: *Bioassays, *Toxicity, *Industrial effluents, *Oil industry, Trout, Daphnia, Salmonella, Ames test, Fish, Bacteria, Crustaceans, Water pollution effects.

The toxicity of effluents from a petrochemical industry center in southern Finland was tested by conducting bioassays on organisms from three different trophic levels. In fish tests, rainbow trout (Salmo gairdneri) were caged at the discharge site and, simultaneously, at a reference area. The only clear differences, among the measurements of 25 metabolic parameters, were observed in fish liver where activities of two detoxication enzymes were significantly increased in the exposed group. The water flea (Daphnia magna) was used both in acute (EC50) and long-term reproduction tests. No acute lethal toxicity was detected in any of the wastewater samples investigated. A combined effluent, however, caused a reduction in the reproduction rate with EC50 of 3%. No mutagenic activity was observed with the Ames test (Salmonella typhimurium, strains TA 97, TA 100) in concentrated effluents, in sediment samples, or in liver samples from predator fish caught from the discharge site. (Author's abstract)
W85-05812

COMBINED ACTION OF CARBARYL AND PHENTHOATE ON TISSUE LIPID DERIVATIVES OF MURREL, CHANNA PUNCTATUS (BLOCH),
Sri Venkateswara Univ., Tirupati (India). Dept. of Zoology.
K. S. Prasada Rao, K. R. S. Sambasiva Rao, I. K. Ahammad Sahib, and K. V. Ramana Rao.
Ecotoxicology and Environmental Safety, Vol. 9, No. 1, p 107-111, February, 1985. 1 Fig, 2 Tab, 19 Ref.

Descriptors: *Carbaryl, *Phenthoate, *Murrel, *Toxicity, *Bioassays, *Fish physiology, *Pesticides, *Synergistic effects, Organophosphorus insecticides, Insecticides, Acaricides, Phenthoates, Water pollution effects.

The levels of total lipids, free fatty acids, cholesterol, and lipase activity were studied in selected tissues of Channa punctatus Bloch during individual and combined exposures of carbaryl and phenthoate. The total lipid levels decreased with elevated levels of free fatty acids and lipase activity during all exposures, suggesting increased lipid hydrolysis to derive energy as an attempt to face the pesticide toxic stress. The cholesterol levels showed an elevated trend. These results were discussed in relation to induced glyconeogenesis and diversion of acetyl-coA to cholesterol synthesis during pesticide treatment. The effect produced by carbaryl + phenthoate treatment remained higher than either of the pesticides alone, suggesting the manifestation of an additive effect. (Author's abstract)
W85-05813

EFFECTS OF VARIOUS ORGANIC CHEMICALS ON THE REGREENING OF RED COLORED CHLORELLA ZOFINGIENSIS,
Hamburg Univ. (Germany, F.R.). Inst. fuer Allgemeine Botanik.
For primary bibliographic entry see Field 5A.
W85-05814

ECONOMIC ASPECTS IN THE INVESTIGATION OF GROUND-WATER CONTAMINATION EPISODES,
Haifa Univ. (Israel).
M. Shechter.
Ground Water, Vol. 23, No. 2, p 190-197, March-April, 1985. 4 Tab, 20 Ref.

Descriptors: *Groundwater pollution, *Economic aspects, *Risk assessment, *Price Landfill, *New Jersey, Path of pollutants, Cost-benefit analysis, Water pollution.

Some economic aspects of ground-water pollution were examined, focusing on the exploitation of an aquifer as a source of drinking water. Using the contamination episode at Price Landfill, New Jersy, as a case study, analytical and information issues which characterize ground-water pollution were addressed. Involved here are uncertainties associated with the environmental medium (especially knowledge of solute-transport processes), and health risk assessment (principally dose-response relationships). The field application employed two approaches to the modeling of the physical-chemical processes to derive mortality risk estimates. These estimates in turn form the basis for preliminary assessment of expected damages: reduced longevity, and cost of control and remedial measures. The results are useful as an essential informational input for a benefit-cost analysis of ground-water protection and management policies. (Author's abstract)
W85-05840

5D. Waste Treatment Processes

SLUDGE DEWATERING IN A CONVENTIONAL PLANT WITH PHOSPHORUS REMOVAL - I; ANALYSIS OF ADDITIONAL COSTS,
Istituto di Ricerca sulle Acque, Rome (Italy).
G. Mininni, R. Passino, M. Santori, and L. Spinosa.
Water Research, Vol. 19, No. 2, p 143-149, 1985. 1 Fig, 6 Tab, 5 Ref, 1 Append.

Descriptors: *Phosphorus removal, *Wastewater treatment, *Sludge drying, *Costs, Economic aspects, Municipal wastewater, Ferrous sulfate, Aluminum sulfate.

Wastewater phosphorus removal and sludge dewatering field tests were run at the Cesenatico (Italy) municipal plant where phosphorus is removed in summer by precipitation with aluminum or ferrous sulfate in the aeration tanks simultaneously with the biological oxidation of organic matter. Characteristics of the sludge produced with or without phosphorus removal were compared. Dewatering tests were carried out on a pilot-scale centrifuge and filter-press mounted on a trailer specifically designed for this type of test. Phosphorus could be removed up to residual concentration of 1.6 mg/l without detrimental effects on the biological process, with an increase of sludge production of 21 and 36% using aluminum or ferrous sulfate respectively. A cost analysis was carried out to assess the costs for phosphorus removal, including the additional one for sludge conditions, dewatering and cake transport to landfill. Additional costs vary from 3290 to 6380 Lit per capita year (29-54%); the higher costs refer to smaller plants (50,000 inhabitants), in which aluminum sulfate is used and sludge dewatered by centrifuge. If costs of chemicals and equipment for phosphorus removal are considered, ferrous sulfate is cheaper than aluminum sulfate (average saving 25%) and the total costs consequent upon phosphorus removal by ferrous sulfate range from 3290 to 4950 Lit per capita per year (+29 to +41% of the total treatment cost). Use of ferrous rather than aluminum sulphate allows savings of 1300-1600 Lit per capita per year. (Collier-IVI)
W85-04970

SLUDGE DEWATERING IN A CONVENTIONAL PLANT WITH PHOSPHORUS REMOVAL - II; STUDY ON CENTRIFUGE AND FILTER-PRESS PERFORMANCE,
Istituto di Ricerca sulle Acque, Rome (Italy).
G. Mininni, R. Passino, M. Santori, and L. Spinosa.
Water Research, Vol. 19, No. 2, p 151-156, 1985. 6 Fig, 3 Tab, 7 Ref.

Descriptors: *Sludge drying, *Wastewater treatment, *Filter press, *Centrifugation, *Sludge filters, Phosphorus removal, Pressure filtration Municipal wastewater.

Dewatering tests were carried out at the Cesenatico sewage treatment plant to point out the influence of phosphorus removal on sludge charateristics, using either aluminum or ferrous sulfate. Equipment performance was studied in different conditions to determine the influence of machine operational variables. As far as centrifugation is concerned, the results showed that the most significant variables the dewatered sludge concentration depends on are the beach residence time and liquid ring height. The feed sludge concentration proved a significant variable if all the data obtained in the three phases are considered together. A pressure filtration model for the prediction of final cake concentration was set up based on the correlations of coefficients a and b of the filtrate flow curve (0 = a x t to the b power) with sludge characteristics (concentration, specific resistance to filtration) and with maximum operating pressure. (Author's abstract)
W85-04971

BATCH AND CONTINUOUS CULTURE EXPERIMENTS ON NUTRIENT LIMITATIONS AND TEMPERATURE EFFECTS IN THE MARINE ALGA TETRASELMIS SUECICA,
Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.
V. Weiss, Z. Gromet-Elhanan, and M. Halmann.
Water Research, Vol. 19, No. 2, p 185-190, 1985. 6 Fig, 1 Tab, 24 Ref.

Descriptors: *Limiting nutrients, *Algae, *Tetraselmis, *Batch culture, *Continuous culture, *Wastewater treatment, *Marine algae, Nitrogen, Nutrients, Light intensity, Population density, Water temperature.

Batch growth and chemostat culture experiments were carried out with the marine alga Tetraselmis suecica (Kylin), a unicellular alga which is potentially useful for wastewater treatment by controlled eutrophication. In natural (Mediterranean coastal) seawater enriched with nutrients, at 22 C, under illumination at 12 h/12 h light/dark, with an intensity of 500 ft-candles, the maximal specific growth rate was mu sub max = 0.61/day (base e), measured both in batch and in chemostat experiments. Cell population densities were determined as a function of temperature at fixed dilution rates. The optimal growth temperature was between 25 and 27 C. With an abundant supply of nutrients, it was possible to sustain substantial population densities in the temperature range of 15-32 C. (Author's abstract)
W85-04973

INHIBITORY EFFECT OF REFRACTORY ORGANIC COMPOUNDS PRODUCED BY ACTIVATED SLUDGE MICRO-ORGANISMS ON MICROBIAL ACTIVITY AND FLOCCULATION,
Vysoka Skola Chemicko-Technologicka, Prague (Czechoslovakia). Inst. of Water Technology and Environmental Protection.
J. Chudoba.
Water Research, Vol. 19, No. 2, p 197-200, 1985. 7 Fig, 3 Tab, 7 Ref.

Descriptors: *Refactory organic compounds, *Activated sludge, *Microorganisms, Chemical oxygen demand, Growth kinetics, Saccharidic polymers, Molecular weight.

Production of soluble refractory organic compounds by activated sludge micro-organisms is a common phenomenon, the intensity of which depends on the initial or influent concentration of substrate and the growth conditions of a given culture. The effect of accumulation of these refractory products in a cultivation medium on the activity of activated sludge micro-organisms was investigated. Semicontinuous cultivation of activated sludge micro-organisms was carried out in such a way that all microbial waste products were accumulated in the cultivation medium. Microbial waste products in higher concentrations adversely affected the kinetic activity and the flocculating and settling properties of activated sludge micro-organisms. As a measure of these properties, COD in settled (0.5 h, CODs) and centrifuged (1000 g, CODc) samples can be used. During the waste product-accumulation period, values of CODc and CODs increased from 71 to 2320 mg/l and from 127 to 8320 mg/l, respectively; thus at the end of the experiment biomass did not settle at all. Specific rates of COD removal decreased as a result of waste products accumulation; these rates fell from 100 to 55 mg/g/h during the waste product-accumulation period. The waste products had the following distribution of molecular weights: 39% below 700, 16% 700-10,000, 35% 10,000-50,000 and 10% above 50,000. Approximately 33% of the fraction with molecular weights above 10,000 were saccharidic polymers. (Collier-IVI)
W85-04974

WASTEWATER TREATMENT IN A DEEP AERATION TANK,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
C. Polprasert, and H. S. Raghunandana.
Water Research, Vol. 19, No. 2, p 257-264, 1985. 3 Fig, 5 Tab, 20 Ref.

Descriptors: *Wastewater treatment, *Aeration, *Flotation, Kinetics, Microorganisms, Chemical oxygen demand.

Pilot-scale experiments were conducted to investigate the performance of a deep aeration tank (DAT) (10 m deep) treating a high-strength synthetic wastewater and DAT biokinetics. With a mean cell residence of 2 days with a ratio of food to microorganisms of 1.41 and less, the DAT reactor operating continuously completely mixed and without cellular recycle removed more than 95% of the chemical oxygen demand of the wastewater. The treatment kinetics were observed to follow the Lawrence and McCarty's models in which the values of the kinetic constants Y, kd, k and Ks for this particular operating condition were found to be 0.53, 0.085, 9.25/day and 259 mg/l, respectively. The results of solid separation by flotation, using the hydrostatic pressure developed in the DAT reactor, were satisfactory. However, better flotation results can be expected with the proper design and operation of the flotation tank. (Author's abstract)
W85-04981

ULTRAFILTRATION PROCESSES FOR THE CHARACTERIZATION AND SEPARATION OF LANDFILL LEACHATES,
Manhattan Coll., Bronx, NY. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5A.
W85-04985

STUDIES ON A SELECTED INDUSTRIAL EFFLUENT AND THE RECEIVING STREAM,
Ife Univ. (Nigeria). Dept. of Civil Engineering.
O. Ogedengbe, H. O. Fapohunda, and M. B. Gotau.
International Journal of Environmental Studies, Vol. 23, No. 3/4, p 229-234, October, 1984. 1 Fig, 3 Tab, 6 Ref.

Descriptors: *Nigeria, *Developing countries, *Industrial wastes, *Water pollution sources, Water quality control, Wastewater treatment, Food processing industry.

Many developing countries seem to be unable to establish water quality standards. The only reasonable hope for the foreseeable future seems to lie in voluntary action by industries prompted, perhaps, by gentle persuasion by public-spirited individuals or groups. An effort is this direction was made using an interplay of data collection and analysis and dialogue. Effluents from a bottling and canning factory complex have impaired the quality of Ona stream to such an extent that the water of the stream is unsuitable for irrigation, or any other use. Simple lab treatability studies showed that the canning waste is amenable to biological treatment, preferably aerobic, or possibly facultative. These results were brought to officials of both industries. The studies are to continue covering both effluents, separately and mixed. In the meantime,

treatment options that are being considered include the use of a shallow pond and an oxidation ditch system. Wastewater ponds are easy to build and operate and they perform well in tropical environments. However, they require large areas of land, and this may be a limiting factor. No plant should be constructed unless and until there is proof that it would make a positive difference to downstream users. (Baker-IVI)
W85-05031

REMOVAL OF PHENOL FROM WASTE WATER BY DOUBLE EMULSION MEMBRANES AND CREEPING FILM PERTRACTION,
Bulgarian Academy of Sciences, Sofia. Central Lab. of Chemical Engineering.
L. Boyadzhiev, E. Bezenshek, and Z. Lazarova.
Journal of Membrane Science, Vol. 21, No. 2, p 127-144, November, 1984. 4 Fig, 1 Tab, 14 Ref.

Descriptors: *Wastewater treatment, *Phenols, *Creeping film pertraction, *Double emulsion membranes, Membrane processes, Organic compounds.

The efficiency of two promising pertraction techniques was compared: the double emulsion method (DEM) and the recently proposed creeping film pertraction (CFP). Both methods can be successfully applied for water dephenolization using C10-C13 normal paraffins as intermediate phase. The solvent is water insoluble, non-toxic and relatively inexpensive. DEM provides higher output per unit apparatus volume. More than 80% of the agitator volume is occupied by the treated liquor, against 20 to 25% in CFP. The overall mass transfer coefficient is higher in the case of DEM batch operation than in CFP. If the goal is the production of a more concentrated product solution, continuous CFP shows higher KFa values. The DEM process consists of three steps; the two auxiliary operation, emulsion preparation before and emulsion destruction after the principal mass transfer operation, are both energy consuming. Emulsion breakup, F phase swelling and water occlusion into the emulsion during water treatment are important shortcomings of the DEM technique. They decrease the process efficiency and deteriorate the selectivity of the process, increasing the content of non-extractable species in the R phase. In addition, the use of emulsifiers makes the process more expensive and more complicated, even from the ecological point of view. (Baker-IVI)
W85-05036

WASTEWATER FILTRATION WITH THE AID OF A QUASICONTINUOUSLY-FED COMPACT FILTER FACILITY (ABWASSERFILTRATION MIT HILFE EINER QUASIKONTINUIERLICH BETRIEBENEN KOMPAKTFILTERANLAGE),
Stuttgart Univ. (Germany, F.R.). Inst. fuer Siedlungswasserbau, Wassergutewirtschaft und Abfalltechnik.
M. Roth, and R. Wagner.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 17, p 221-228, 1984. 15 Fig, 2 Tab, 12 Ref.

Descriptors: *Wastewater treatment, *Filtration, *Compact filters, Quasicontinuous feed, Grain size, Suspended solids, Costs.

An experimental compact filter facility for advanced wastewater treatment was tested during two long periods between 1979 and 1982. The facility differs from conventional sand and multilayer filters in the size of its filter granules (round plastic grains with low density 0.5-1.0 mm) and its quasicontinuous feed together with external flushing of used granular material. The fine filter material makes filter speeds possible that are twice as high as those of conventional sand filters. High filter speeds allow smaller facilties and thus reduced investment costs. Experiments were performed at constant flow-through of 4.0 or 10.0 cu m/hr at filter speeds of 14 or 35 m/hr, respectively. During the experiment at 14 m/hr, 5-day BOD sludge load in the biological-treatment stage that precedes filtration was 0.09-0.21 kg/(kg.day) with an activated-sludge index of 130-180 ml/g; for the run at 35 m/hr, corresponding values were 0.20-0.35 kg/(kg.day) and 100 mg/l - to test the filter at higher inflow pollution levels, biologically treated water was taken from various depths of the basin. At 14 m/hr, median suspended-solids removal rate was 67.5%, and the filter was more effective than a sand filter operated at 15 m/hr, corresponding in its removal rate to a sand filter at 5 m/hr. At 35 m/hr, median suspended-solids removal rate was 45.3%; with far greater spread than at 14 m/hr in contrast to conditions at 14 m/hr, there was no relationship between inflow pollution level and removal rate. Use of the new filter in municipal wastewater treatment will only be possible with trained personnel. (Gish-IVI)
W85-05041

PILOT SCALE STUDIES ON ENHANCED BIOLOGICAL PHOSPHORUS REMOVAL IN AN ACTIVATED SLUDGE TREATMENT PLANT WITH NITRIFICATION AND PREDENITRIFICATION (UNTERSUCHUNGEN UBER DIE BIOLOGISCHE PHOSPHOR-ELIMINATION IN EINER HALBTECHNISCHEN VERSUCHSANLAGE MIT WEITGEHENDER NITRIFIKATION UND VORGESCHALTETER DENITRIFIKATION),
Stuttgart Univ. (Germany, F.R.). Inst. fuer Siedlungswasserbau, Wassergutewirtschaft und Abfalltechnik.
P. Kainrath, K. Krauth, W. Maier, and R. Wagner.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 17, p 245-251, 1984. 5 Fig, 5 Tab, 23 Ref.

Descriptors: *Phosphorus removal, *Biological treatment, *Nitrification, *Denitrification, *Activated sludge, Chemical precipitation, Wastewater treatment.

In activated sludge treatment the enhanced biological removal of phosphorus from domestic sewage is possibly an alternative to the established method of phosphorus precipitation with ferric, aluminum or calcium salts. However it is not yet clear, whether or not this method might be practicable in Central-Europe with the wastewater and temperature conditions existing there. The results of experiments in a pilot-scale activated sludge treatment plant are presented the influence of the composition of the influent, the retention time in the various basins, the variation of the organic sludge load and the seasonal profiles were investigated in ten different experimental periods during the past two years. The process design was also changed during the investigations in order to examine the influence of the system configuration. The aim of these experiments, which are still in progress, is to investigate the possibilities for the technical realization of the method presented. (Author's abstract)
W85-05042

FLOCCULATION EFFECTS ON BOUND WATER IN SLUDGES AS MEASURED BY NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY,
Delaware Univ., Newark. Dept. of Civil Engineering.
J. B. Carberry, and R. A. Prestowitz.
Applied and Environmental Microbiology, Vol. 49, No. 2, p 365-369, February, 1985. 6 Fig, 2 Tab, 15 Ref.

Descriptors: *Nuclear magnetic resonance spectroscopy, *Flocculation, *Sludge, Wastewater treatment, Spectroscopy.

Flocculation of biological sludges is not well understood mechanistically or quantitatively; the ease of dewatering is related to flock particle formation. Properties of bound water in sludges of various degrees of flocculation were investigated by nuclear magnetic resonance spectroscopy (NMR). NMR relaxation times (T1 and T2) were measured for flocculated and unflocculated samples of activated sludge. The weight of water and solids in the sludge samples was found and related to T1 to find the relative percentage of bound water. The results suggest that the amount of bound water increases as the samples become more unflocculated. The values of T1 and T2 also indicate that unflocculated individual particles are characterized by loose packing of shorter molecules and that the addition of larger molecules may induce flocculation. Sample preparation is important in determining the results; even mild centrifugation is not recommended for sample concentration. (Collier-IVI)
W85-05049

COMPARING PRIORITY POLLUTANTS IN MUNICIPAL SLUDGES,
Camp, Dresser and McKee, Inc., Annandale, VA.
C. Gricke, C. Clarkson, E. Lomnitz, and T. O'Farrell.
Biocycle, Vol. 26, No. 1, p 35-37, January/February, 1985. 2 Tab, 1 Ref.

Descriptors: *Sludges, *Chemical composition, *Municipal wastewater, *Priority pollutants, Pollutant identification, Polychlorinated biphenyls, Pesticides, Acids, Organic compounds, Selenium, Beryllium, Zinc, Copper, Metals, Volatile compounds.

In 1978 a program was initiated by the US EPA to study the fate and occurrence of 129 priority pollutants in 50 Publicly Owned Treatment Works (POTW). A key finding of this study was that some pollutants found in POTW influents at low frequencies of occurrence were measured at higher frequencies in the corresponding sludge streams. An analysis of the EPA study results was made in comparison with results of other available municipal sludge data bases. This comparison brings into clearer focus what pollutants are present in municipal sludges nationwide, and characterizes their frequency and concentration. With the exception of selenium and beryllium, all the metals examined in this analysis were detected at virtually all of the plants with zinc appearing in the highest concentrations. Of the three acid compounds, phenol was the most prevalent but was found at lower concentrations than pentachlorophenol and 2,4,6-trichlorophenol. Bis(2-ethylhexyl)phthalate was the most prevalent base/neutral compound and was also found at a concentration higher than any of the other base/neutral compounds. As a group, the pesticides and PCB's were detected less frequently and at a lower concentration than any of the other compounds. Chlordane was the most frequently detected at 36% of the POTWs with PCB's next at 31%. (Baker-IVI)
W85-05057

REMOVAL OF ORGANIC AND TOXIC SUBSTANCES FROM DEBARKING AND KRAFT PULP BLEACHING EFFLUENTS BY ACTIVATED SLUDGE TREATMENT,
J. Junna, R. Lammi, and V. Miettinen.
Vesientutkimuslaitoksen Julkaisuja, No. 49, p 17-29, 1982. 7 Fig, 9 Tab, 21 Ref.

Descriptors: *Pulp wastes, *Kraft mills, *Wastewater treatment, *Bleaching wastes, *Activated sludge, *Toxicity, Bioassays, Biological oxygen demand, Trout, Water pollution effects.

Bleaching is presently the most significant source of pollution in pulp mill processes in Finland. Pilot plant experiments were carried out in a Finnish kraft mill to test the treatment of combined debarking and bleaching effluent by the activated sludge method. The kraft mill used a typical multistage chlorine bleaching method and conventional wet debarking drums were used for debarking. The tests were run with a normal one-stage activated sludge system. The organic load of the pilot plant was about 1 kg/cu m BOD7. The best BOD7-reduction obtained was 60-80%. Ether-soluble compounds were removed from the combined effluent at an efficiency of 51%. Resin acids, an important group of toxic compounds, were reduced efficiently, the average reduction being 75%. The reduction of chlorinated phenolics was usually 30-40%, and at best about 60%; these compounds form during the bleaching process from chlorine, and chlorine dioxide, and lignins. During the overall period, the reduction of fatty acids was 53% and that of sterols 54%. Acute toxicity (LC-50 96 h) to trout was reduced by at least 70%. Long term toxicity tests (20 d) revealed that the treatment reduced sublethal effects and the accu-

mulation of resin acids in trout. In fish exposed to treated effluent, the concentrations were only half of the concentrations measured in fish exposed to untreated effluent; concentration levels were determined with bile and blood plasma analyses. Compounds tainting fish fillets were also reduced. (Collier-IVI)
W85-05061

WATER REUSE: WHERE ARE WE HEADED,
Orange County Water District, Fountain Valley, CA.
D. G. Argo.
Environmental Science and Technology, Vol. 19, No. 3, p 208-214, March, 1985. 1 Fig, 4 Tab, 21 Ref.

Descriptors: *Water reuse, *Drinking water, *Aquifer recharge, *California, Water supply development, Water supply, Water treatment, Reverse osmosis, Artificial recharge.

For the past 60 years, Californians living in the southern portion of that state have been importing water to supplement the inadquate local supply. Preliminary studies indicate that recharge of the groudwater supplies for this area through a series of injection wells would require as much as 36,990,000 cu m of water per year. After weighing all the factors, including consideration of the availability of supply, reliability, environmental problems, quality, and program costs, it was determined that the best source of barrier injection would be reclaimed water. Water Factory 21 (WF21) was conceived and constructed to provide a source of recharge water for the injection barrier. It has been in operation since October 1976 and has produced nine trillion gallons of treated, reclaimed water. The treatment process includes lime clarification with sludge recalcining, air stripping, recarbonation prechlorination, mixed-media filtration, granular activated carbon adsorption with regeneration, final chlorination, and reverse osmosis demineralization. WF21 has demonstrated its reliability in meeting EPA drinking water standards. Especially when RO is included, the treatment processes have gone beyond existing standards and have shown the ability to reduce the concentration of priority pollutants below mandated health criteria. (Baker-IVI)
W85-05116

ETHYLBENZENE, ENVIRONMENTAL AND TECHNICAL INFORMATION FOR PROBLEM SPILLS.
Environmental Protection Service, Ottawa (Ontario).
Envirotips Manuals, February 1984. 93 p, 28 Fig, 8 Tab, 195 Ref.

Descriptors: *Water pollution control, *Benzenes, *Aquatic Life, Environmental Quality, Pollutants, Problem Spills, Cleanup, Skimming, Ethylbenzene, Hazardous materials, Toxicity, Contamination, Bioaccumulation, Sewers.

Technical and environmental information for handling and preventing problem spills of ethylbenzene are presented. Ethylbenzene is a colorless liquid with a sweet, gasoline like odor. Its synonyms include Phenylethane, Ethylbenzol, and EB. Ethylbenzene is a flammable liquid; its vapors form explosive mixtures in air at concentrations of 1.0 to 6.7%. It is moderately toxic by inhalation, contact and ingestion to humans. Ethylbenzene is harmful to some species of aquatic life at concentrations as low as 0.4 mg/l. An ethylbenzene slick could pose an immediate hazard to waterflow and marine animals. It is harmful to aquatic life in low concentrations, but has not been shown to be bioaccumulative or bioconcentrative. Immediate action for spill control requires access restriction to the spill site, calling the fire department, and notification of the manufacturer. Sources of ignition, including traffic and equipment, need to be eliminated. It is necessary to keep contaminated water from entering sewers or watercourses. Emergency control procedures in water include: contain with booms, weirs or natural barriers. Use skimming equipment to remove the slick, followed by the application of sorbents.
W85-05126

PROCESS DESIGN MANUAL FOR LAND APPLICATION OF MUNICIPAL SLUDGE,
SCS Engineers, Inc., Long Beach, CA.
K. LaConde, C. Schmidt, H. V. Lam, T. Boston, and T. Dong.
Environmental Protection Agency, Report EPA-625/1-83-016, October 1983. 410 p, 53 Fig, 125 Tab, 398 Ref, 5 Append.

Descriptors: *Sludge Utilization, *Municipal Wastes, Land Disposal, Land Reclamation, Design Standards, Site Selection, Sludge Disposal, Public Participation, Agriculture, Surface Water, Groundwater.

A rational procedure for the design of municipal sludge land application systems is presented. The utilization of sludge in agriculture, forestry, the reclamation of disturbed and marginal lands, and dedicated high rate surface disposal practices are discussed in detail, with design concepts and criteria presented where available. A two phased planning approach to site identification, evaluation, and selection along with information on field investigations are also presented. The manual includes examples of each land application option and case studies of sludge utilization in agriculture and for reclamation of disturbed mining lands.
W85-05127

DESIGN MANUAL, MUNICIPAL WASTEWATER STABILIZATION PONDS,
Clemson Univ., SC.
E. J. Middlebrooks, J. H. Reynolds, C. Middlebrooks, R. W. Schneiter, and R. J. Stenquist.
Environmental Protection Agency, Report EPA-625/1-83-015, October 1983. 327 p, 99 Fig, 55 Tab, 253 Ref, 1 Append.

Descriptors: *Wastewater Facilities, *Design Criteria, Municipal Wastewater, Suspended Solids, Cost Analysis, Ponds, *Stabilization Ponds, Aerated Lagoons, Municipal wastes, Wastewater treatment.

A concise overview of wastewater stabilization pond systems is provided through a discusssion of factors affecting treatment, process design principles and applications, aspects of physical design and construction, suspended solids (SS) removal alternatives, and cost and energy requirements. A review of physical and biological factors associated with wastewater stabilization ponds is provided. Empirical and rational design equations, and their ability to predict pond performance, are also discussed. Actual design examples employing the rational equations are provided. These examples encompass essentially all types of wastewater ponds currently in use in the United States. Physical design and construction criteria are discussed. These criteria are vital to effective pond performance regardless of the design equation employed and must be considered in facility design. High SS concentrations in pond effluents have traditionally represented a major drawbacks to their use. Alternatives for SS removal and control are presented. Cost and energy requirements are useful to aid in process selection and justification. An evaluation of various facultative and aerated pond design methods is presented in an Appendix. This evaluation was performed using data collected on the 4 facultative and 5 aerated pond systems presented.
W85-05133

HANDBOOK FOR IDENTIFICATION AND CORRECTION OF TYPICAL DESIGN DEFICIENCIES AT MUNICIPAL WASTEWATER TREATMENT FACILITIES.
Municipal Environmental Research Lab., Cincinnati, OH.
Report EPA-625/6-82-007, April 1982. 409 p.

Descriptors: *Municipal Wastewater, *Wastewater Facilities, *Design Standards, Activated Sludge, Sludge Drying, Sludge Disposal, Lagoons, Aerobic Digestion, Anaerobic Digestion, Lagoons.

The handbook was prepared for use by engineers involved in the design of publicly-owned treatment works (POTWs). Its intent is to identify design deficiencies found to limit the performance of POTWs. Design considerations are developed that eliminate the deficiencies during the design phases of the project. Typical design deficiencies found in POTWs are identified and associated methods to correct each of the deficiencies noted are presented. The handbook describes design deficiencies that contribute to performance and reliability problems, poor safety practices, and/or decreased flexibility of plant process control. The result of such deficiencies may be any combination of increased plant operations and maintenance, cost, and energy requirements. The handbook is intended to provide design engineers with guidance that will make their designs more operable and maintainable at less cost, as well as more flexible in providing adequate performance during times of changing influent characteristics. The topics include: design considerations, preliminary treatment, primary treatment, air activated sludge, oxygen activated sludge, trickling filter, disinfection, anaerobic digestion, aerobic digestion, sludge dewatering, lagoons, land application, sludge disposal, sludge reduction, and rotating biological contactors.
W85-05135

REMOVAL OF VOLATILE CHLORINATED HYDROCARBONS FROM GROUNDWATER (ENTFERNUNG LEICHTFLUCHTIGER CHLORKOHLENWASSERSTOFFE AUS GRUNDWASSER),
For primary bibliographic entry see Field 5G.
W85-05136

ION-EXCHANGE PROCEDURES (IONENAUSTAUSCHVERFAHREN).
For primary bibliographic entry see Field 5F.
W85-05137

CALCULATING REFERENCE LEVELS FROM MAXIMUM LEVELS (BEZUGSWERT-ERRECHNUNG AUS HOCHSTWERTEN).
For primary bibliographic entry see Field 6E.
W85-05138

ADAPTED MICROORGANISMS REPLACE DESTROYED BIOMASS (ADAPTIERTE MIKROORGANISMEN ERSETZEN ZERSTORTE BIOMASSE),
W. Rucken.
Wasser, Luft und Betrieb, Vol. 28, No. 3, p 14-16, March, 1984. 2 Fig.

Descriptors: *Microorganisms, *Biomass, *Biological wastewater treatment, Industrial wastewater, Plastics industry, Wastewater treatment.

Specially bred mutated microorganisms were used to replace biomass destroyed by an unexpected sudden increase in volume and pollution level of wastewater at the Ruhle wastewater-treatment facility on the Ems River (Federal Republic of Germany). Biomass destruction by a rush of wastewater from a synthetic-resin plastic manufacturing plant occurred in 1982 just after the original biomass had been pumped into a new activation basin. Activated sludge brought in as inoculating sludge failed to rebuild an effective biomass despite introduction of only small quantities of the heavily polluted wastewater to be treated. Mutated adapted microorganisms (noggies) were applied to the system. A marked improvement in degradation capacity was seen on day 3. Application of noggies was stopped after 30 days to discover whether the basin had developed its own biomass; it was found that the facility could run smoothly and effectively without further application (total quantity of noggies used in 30 days was 30 kg). Since noggies can be stored for years in a dry place, a supply was retained for possible future problems. (Gish-IVI)
W85-05139

BIOZWEI TUBE-REACTOR PROCEDURE (DAS ROHRREAKTOR-VERFAHREN BIOZWEI),

Messer Griesheim G.m.b.H., Duesseldorf (Germany, F.R.).
W. Mack.
Wasser, Luft und Betrieb, Vol. 28, No. 6, p 18-21, June, 1984. 5 Fig, 2 Ref.

Descriptors: *Biological wastewater treatment, *Biozwei tube reactor, Wastewater treatment, Industrial wastewater, Oxygen, Aeration, Activated sludge process.

The Biozwei tube reactor is suited to the biological treatment of heavily polluted industrial wastewater due to its high specific-load capacity, ability to handle highly variable pollution levels in inflow, and low sludge index. The horizontal tubular shape of the reactor, which differs markedly from conventional activation basins, together with pressurized aeration with pure oxygen, allows a chronological separation of substrate and endogenous respiration by microorganisms. The flow of the wastewater/activated-sludge mixture horizontally through the reactor is superimposed by a spiral flow about the horizontal axis to achieve an even horizontal flow and minimize backflow. This results in substrate degradation at higher speeds than in conventional facilities. When the substrate is fed in, intensive respiration begins spontaneously (high substrate concentrations cause the microorganisms to synthesize increased quantities of enzymes), reaching a peak after about 15 min and decreasing only when almost all the substrate has been decomposed. The high performance level of Biozwei is made possible by the use of pure oxygen rather than air; its enclosed design makes it possible to capture and reapply to the activated sludge any unused oxygen, resulting in a 95% exploitation rate. A transportable experimental Biozwei reactor was used to treat wastewater from a pulp factory, garbage-dump percolating water, wastewater with high carbohydrate content, and wastewater from an animal-products plant. Results were good in all cases: e.g., COD removal in pulp wastewater and dump percolating water was > 90%. (Gish-IVI)
W85-05141

WASTEWATER PURIFICATION IN THE HIDE GLUE INDUSTRY (ABWASSERREINIGUNG BEI DER HAUTLEIMINDUSTRIE),
Stuttgart Univ. (Germany, F.R.). Inst. fuer Siedlungswasserbau, Wassergutewirtschaft und Abfalltechnik.
K. F. Staab, M. Roth, M. R. Stuttgart, and R. Binder.
Wasser, Luft und Betrieb, Vol. 28, No. 7-8, p 15-18, July/August, 1984. 4 Fig, 6 Tab, 6 Ref.

Descriptors: *Biological wastewater treatment, *Industrial wastewater, *Glue industry, Percolating filters, Wastewater treatment, Nitrification.

A wastewater-treatment plant at a hide-glue factory was originally designed for 3,600 cu m/-day wastewater, 5-day BOD sludge and volume loads of 0.4 kg/(kg.day) and 1.0 kg/(cu m.day), and a residence time of 12 hr. Effluent quality varied greatly, but was satisfactory for 5 yr until 5-day BOD in inflow had more than doubled, resulting in a higher sludge index and increased levels of 5-day BOD and COD in effluent. Experiments with a submerged, plastic-filled percolating filter resulted in a 52% decrease in 5-day BOD and a 46% decrease in COD at a 5-day BOD volume load of 2.5 kg/(cu m.day) and corresponding decreases of 44.4% and 40.4% at a volume load of 6.0 kg/(cu m.day); at the latter volume load, the filter was stopped up by lime deposits after 1 mo despite high rinse speeds of 1.9 m/hr. The filter therefore reduced organic pollution satisfactorily but lacked operational stability, so the facility was expanded by adding a further activation basin. The expanded biological stage was designed for a 5-day BOD load in inflow of 4,200 kg/day with a wastewater volume of 3,600 cu m/day. By introducing nitrification in the second stage, the strongly alkaline wastewater was neutralized to the extent that the original neutralization basin was no longer needed. Results of expansion were good with sludge index being reduced from 200 to about 50 ml/g, and the quality of effluent being so high that the factory was considering using it as wash water. (Gish-IVI)
W85-05142

MATHEMATICAL MODEL OF THE PROCESS OF POLLUTANT REMOVAL IN ROTATING DISK BIOFILTERS,
V. A. Vavilin, and S. S. Kuz'min.
Water Resources, Vol. 11, No 2, p 163-168, March-April, 1984. 6 Fig, 1 Tab, 16 Ref. Translated from Vodnye Resursy, No. 2, p 143-149, March-April, 1984.

Descriptors: *Wastewater treatment, *Biofilters, Filtration, Biological treatment, Industrial wastewater, Municipal wastewater, Mathematical models, Rotating disk biofilters.

Biodisks (rotating disk biofilters) are modifications of biofilters which provide a greater waste-treatment time. Biodisks have recently become popular for treating both domestic and industrial wastewaters. The polluting organic matter is consumed by the biofilm covering the surface of the rotating disks. Due to rotation of the disks the biofilm receives the necessary amount of oxygen. Usually the rotational speed does not exceed 2-10 rpm. The functioning of a complex community of microorganisms underlies the biological treatment process. Despite this, relatively simple formal models based on aggregated variables can be used in an engineering calculation of the volume of a treatment plant. The earlier proposed unified model of biological treatment for various types of reactors can be used successfully for calculations for rotating disk biofilters. Unlike biodisks with transverse rotation of the shaft, in biodisks with longitudinal rotation a succession of attached microoganisms along the waste liquid flow occurs. It is as though the successive removal of components of a multicomponent pollutant occurs. Such specialization of microorganisms leads to greater effectiveness of treatment. (Baker-IVI)
W85-05160

PROCESS DESIGN MANUAL, LAND TREATMENT OF MUNICIPAL WASTEWATER,
Metcalf and Eddy, Inc., Sacramento, CA.
R. W. Crites, E. L. Meyer, R. G. Smith, M. Walker, and K. Alston.
Environmental Protection Agency, Report EPA 625/1-81-013, October 1981. 458 p, 88 Fig, 141 Tab, 262 Ref, 7 Append.

Descriptors: *Municipal wastewater, *Wastewater facilities, Site selection, *Land disposal, Hydraulic loading rate, Subsurface drainage, Groundwater, Disposal, Design standards, Infiltration, Overland flow, Environmental effects, Toxicity.

A rational procedure for the design of land treatment systems is presented. Slow rate, rapid infiltration, and overland flow processes for the treatment of municipal wastewaters are discussed in detail, and the design concepts and criteria are presented. A two-phased planning approach to site investigation and selection is also presented. The manual includes examples of each process design. Information on field investigations is presented along with special considerations for small scale systems. Equations and procedures are included to allow calculations of energy requirements for land treatment systems. Potential health and environmental effects and corresponding mitigation measures are discussed.
W85-05194

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON NEW TECHNOLOGY FOR WASTEWATER TREATMENT AND SEWERAGE IN RURAL AND SUBURB AREAS.
Tampere Univ. of Technology (Finland). Dept. of Civil Engineering.
October 3-6, 1983, Hanasaari, Finland. 1984. 449 p. Rantala, P., Santala, E., and Vikman, H., Editors. 95 Fig, 68 Tab, 204 Ref.

Descriptors: *Wastewater treatment, *Conferences, *Regulations, *Rural areas, *Sewer systems, *Water policy, *Septic tanks, *Composting, *Land disposal, *Absorption, *Wastewater disposal, *Education, Reviews, Symposium, Pulp and paper industry, Sewers, Wastewater management, Septic wastewater, Wastewater, Septic sludge, Soil amendments, Soil treatment, Waste disposal, Scandinavia, United States, Pulp wastes, Wastewater renovation.

This international conference was organized by the Tampere University of Technology to enable the exchange of experiences, ideas and plans for water pollution control in rural areas where conventional sewerage systems are not feasible. The proceedings cover six areas of wastewater treatment technology: policy and regulations, sewerage and septic tanks, composting toilets and package treatment plants, the soil as a renovating medium for wastewater, the design, construction and function of soil absorption systems, and training and research programs. Most of the papers given at the conference focus on sewerage and wastewater treatment systems in rural areas of the United States or Scandinavian countries. Municipal and industrial wastes are cited as the main sources of water pollution and eutrophication of lakes and rivers. In Scandinavia and North America, the pulp and paper industry has been the major polluter. Special emphasis was put on experiences and future trends in different types of soil absorption systems.
W85-05195

OVERVIEW OF ON-SITE WASTEWATER TREATMENT AND DISPOSAL,
Washington Univ., Seattle. Dept. of Civil Engineering.
R. W. Seabloom.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 15-22, 2 Ref.

Descriptors: *Wastewater treatment, *Land disposal, *Septic wastewater, *Wastewater disposal, *Soil absorption, *Sewer systems, Wastewater management, Rural areas, Developing countries, Absorption, Septic tanks, Sewers.

The implementation or lack of implementation of on-site wastewater disposal systems in developed countries has been influenced by many factors and decisions of many different parties. On-site wastewater disposal systems were generally perceived as inadequate and temporary and regulations to manage them were often biased and unnecessarily restrictive. Centralized systems required large federal subsidies, the cost of which were not always borne by those creating the water pollution problem. Engineers and regulatory officials in general have been unaware of the cost and performance of on-site wastewater disposal systems due to the traditional education scheme which focuses on conventional wastewater treatment systems. Extensive growth inducing properties common to conventional gravity sewers are not generally a serious concern with on-site systems. Engineers must recognize that properly sited, designed, constructed and maintained on-site systems are cost effective and in many cases are the preferred solution.
W85-05196

POLICY AND REGULATIONS IN SCANDINAVIA,
National Board of Waters, Helsinki (Finland). Office for Water Supply and Sewerage.
H. Vikman.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 23-29.

Descriptors: *Wastewater treatment, *Regulations, *Water policy, *Wastewater management, *Land disposal, *Scandinavia, *Water pollution control, *Local governments, Pulp and paper industry, Water quality standards, Soil absorption, Absorption, Sweden, Denmark, Finland, Norway, Sewer systems, Wastewater disposal, Rural areas, Acidification.

Differences in topography and population density have made wastewater treatment practices differ in

the Scandinavian countries. In Denmark, the municipal government maintains strict regulations for the treatment and disposal of rural wastewaters. In Finland, more emphasis will be put on the reduction of pollution load from pulp and paper industry in the 1980's. The municipal water boards and boards of health are responsible for small-scale wastewater systems in Finland. The protection of the marine ecosystem is considered vitally important in Norway where water pollution is controlled at the regional level by the municipal boards of construction. In Sweden, a water acidification problem exists in the south. The responsible authority in Sweden is the board of health. Quality standards for effluents from individual or small-scale sanitation utilities have not been applied in Scandinavia, but are substituted by certain technologies to be used in various circumstances or setting of standards on minimum distances between on-site treatment utilities and groundwater intakes or watercourses. New guidelines on soil absorption methods are to be released as a result of a joint venture by Norway and Sweden.
W85-05197

ONSITE WASTEWATER SYSTEMS POLICY AND REGULATIONS IN THE USA,
Municipal Environmental Research Lab., Cincinnati, OH.
J. F. Kreissl.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 31-45, 15 Ref.

Descriptors: *Wastewater treatment, *Land disposal, *Soil absorption, *Wastewater disposal, *Local governments, *Waste management, *Public health, *Regulations, *Septic tanks, Water pollution control, Waste disposal, Design criteria, Site selection, Water law, Septic wastewater, Reviews, Runoff, Sanitation.

With the passing of the Clean Water Act of 1977 in the United States, on-site wastewater disposal systems were to receive increased government funding in communities with populations of < 3,500 or in sparsely populated areas of larger communities. Most state codes for the design of conventional on-site systems are based on the premise of protecting public health. Soil absorption systems must have proper siting, design and construction to prevent contamination of groundwater or overland runoff. With improved site evaluation capability and availability of new technologies to provide sanitation for almost any site, flexible guidance criteria has replaced the use of restrictive codes in many circumstances. In Maine, licensed state evaluators provide extensive soil evaluations prior to system identification, design and installation. Other states are increasing their emphasis on qualified site evaluations thus reducing the lag time between technological advances and code changes.
W85-05198

LOCAL WATER AND SEWAGE SYSTEM PLANNING,
EFEM A.B., Goeteborg (Sweden).
H. Bjur, and B. Malbert.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 47-63.

Descriptors: *Legal aspects, *Social aspects, *Wastewater treatment, *Rural areas, *Sweden, *Wastewater disposal, *Project planning, *Local governments, Waste disposal, Water policy, Economic aspects, Regulations, Sewer systems, Septic tanks, Wastewater management.

In Sweden, the construction of underground sewers in towns commenced in the 1860's in response to industrialization. Refuse collection by law was initiated in 1905. In the late 1950's, all dwellings in urban areas had to be connected to centralized water and sewage plants. In 1962, the National Road Board called for the use of septic tanks and sand filter trenches in rural areas. In rural areas, the problem exists of choosing the best small-scale water and sewage technique. Municipal planners should conduct water-sewer (WS) surveys to see where and when the municipal network can be extended and where and when a special WS survey must be made. The choice of a WS system depends on the extent of development of the area being considered, its natural resources, and the social situation of the physical environment. In 1974 the Plant Act was issued to assist and control the implementation of private installations. It regularizes the formation of one joint installation for several properties. Great demands are made on the competency of the project consultants and contractors. The need for maintenance and regular inspection increases in accordance with plant size. The utilization of local resources in the operation of the WS plant should also be considered.
W85-05199

QUANTITY AND CHARACTERISTICS OF RESIDENTIAL WASTEWATER,
National Board of Waters, Helsinki (Finland). Planning Office.
E. Santala.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 67-78, 7 Tab, 16 Ref.

Descriptors: *Wastewater treatment, *Septic tanks, *Wastewater disposal, *Finland, Rural areas, *Municipal wastewater, Septic wastewater, Municipal wastes, Effluents, Wastewater, Wastewater management, Water use, Water use efficiency, Consumptive use, Nonconsumptive use, Land disposal.

In Finland, the per capita consumption of water is generally lower in smaller towns and rural areas than in Helsinki. The main uses of water and production of wastewater within a household are use of water for personal hygiene, laundering, dishwashing, and drinking, food preparation and cleaning. Water consumption is best reduced by using minimum-flow fixtures and low-flush toilets. In rural and suburban residences, wastewater flow is nearly equal to water use. Pollutant load in residential wastewater depends mostly on family size, toilet type and water use habits. The wastewater influent to septic tank or on-site treatment plant has higher pollutant concentrations than those in influent to municipal treatment plants due to the quantity of leakage water. Results of a 1981-82 study of septic tanks in Finland showed that the effluent from both blackwater and graywater septic tanks was strong and quite similar for suspended solids, biological oxygen and total phosphorus. Total nitrogen values were much lower in graywater effluent even though they were higher than expected.
W85-05200

ALTERNATIVE SEWER SYSTEMS IN THE UNITED STATES,
Municipal Environmental Research Lab., Cincinnati, OH.
J. F. Kreissl.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 79-115, 5 Fig, 6 Tab, 17 Ref.

Descriptors: *Sewers, *Wastewater treatment, *Sewer systems, *Design criteria, *Sewer hydraulics, *Pressure conduits, *Domestic wastes, Vacuum sewers, Small-diameter gravity sewers, Pressure sewers, Capital costs, Operating costs, Maintenance costs, Comparison studies, Septic tanks, Cost analysis, Conduits, Wastes, United States.

In rural areas in the United States, monthly sewerage charges above twenty dollars/mo are considered excessive. Usually on-site systems cost less than this and therefore have been used in rural areas. Three types of alternative collection systems for human wastes-pressure, vacuum and small-diameter gravity (SDG) sewers are discussed. Pressure sewers have low installation costs. Since pressure sewers are sealed conduits, infiltration is eliminated and treatment plants can be designed to handle only domestic sewage. Pressure sewers may incur higher operational and maintenance costs. There are two types of SGD sewers, those with relatively constant grade and those with variable grade. SGD sewers incur lower capital costs than conventional gravity sewers but they require continued maintenance of septic tanks and corrosion and odor control. The vacuum sewer also offers reduced capital costs due to the small plastic pipe used and reduced depth of installation. Wastewater from a vacuum sewer has a higher dissolved oxygen content. However, vacuum systems require more energy for operation per unit volume of wastewater transported, greater potential for infiltration, and special design requirements for grade alignment and allowable system lift. The choice of one of these sewer systems over the other depends upon topography, geology/hydrology, available management, power, habitation, termination facilities, climate, and population density and growth and treatability.
W85-05201

SEPTIC TANK DESIGN,
Washington Univ., Seattle. Dept. of Civil Engineering.
R. W. Seabloom, D. A. Carlson, and J. Engeset.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 117-134, 4 Fig, 3 Tab, 10 Ref.

Descriptors: *Septic tanks, *Septic wastewater, *Wastewater treatment, *Wastewater disposal, Wastewater, Septic sludge, Domestic wastes, Biological wastewater treatment, Waste disposal, Suspended solids, Sedimentation, Biological oxygen demand, Pathogens, Phosphorus compounds, Nitrogen compounds.

The septic tank provides for the separation, storage, and digestion of suspended solids as well as for the growth, reproduction, and death of large numbers of anaerobic organisms. A septic tank with greater surface area is more effective than one with a smaller surface area if the volume is the same. Septic tanks for residential use are usually made of concrete and are precast for installation in the field. They are sized on the expected number of bedrooms served. Septic tanks should be equipped with inlet and outlet devices to minimize turbulence and carry-over of solids. They should be pumped out of sludge and scum every three to five years. Recent studies suggest no advantages in septic tank compartmentation. Septic tanks appear to be unaffected by hydraulic stressing produced by wash day, vacation and a weekend party of house of guests. The effluent from a septic tank contains suspended solids, biological oxygen demand, and P compounds, as well as pathogens which prohibit its discharge into water courses or on land. Septic tank effluent always requires additional treatment in the soil by a subsurface soil absorption system.
W85-05202

EXPERIMENTS WITH TESTING OF SEPTIC TANKS,
Teknologisk Inst., Tastrup (Denmark).
I. Faldager.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 135-145, 3 Fig, 4 Tab, 2 Ref.

Descriptors: *Septic tanks, *Comparison studies, *Artificial sludge, *Design criteria, *Performance evaluation, Wastewater treatment, Septic sludge, Septic wastewater, Suspended solids, Sludge.

The ability of four types of septic tanks (one chamber, two chamber, small Emcher, and big Emcher)

to detain settleable solids and sludge already settled was examined. A polystyrene artificial sludge was used in the tests. Results showed that the one-chamber tanks gave the worst performance. A cap on the outflow of the one-chamber tank had a favorable effect on the outflow concentration. Insertion of a second chamber diminished the total outlet of particles by more than 50%. A traditional 1 m septic tank succeeded by a smaller septic tank (second chamber) gave the best results. Characteristically, all the one-chamber tanks showed a high concentration of artificial sludge in the beginning of testing while the insertion of a second chamber resulted in the largest sludge concentrations in the outflow appearing at the end of testing. The insertion of even a small second chamber takes away the peak of the large concentration in the outflow at the few big outflows and thus improves the function of the tank considerably.
W85-05203

SEPTAGE QUANTITY, CHARACTERISTICS AND TREATMENT METHODS,
Norsk Inst. for Vannforskning, Oslo.
A. S. Eikum.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 147-166, 8 Fig, 8 Tab, 13 Ref.

Descriptors: *Wastewater treatment, *Septic tanks, Sludge digestion, Aerobic digestion, *Anaerobic digestion, *Municipal wastewater, *Septic sludge, *Septic wastewater, Norway, Wastewater disposal, Germany, Sweden, Biological wastewater treatment, United States, Municipal wastes, Sludge drying, Dewatering, Sludge thickening, Sludge solids.

In Norway specific septage quantity was found to be 0.35 cu m/person/yr. In Sweden a value of 0.20 cu m/person/yr has been recommended for design purposes. The amount of septage from a septic tank will depend on the volume of the tank, how often the tank is emptied, and the procedure used when emptying the tank. Calculated volumes of septage are inadequate for designing the treatment capabilities of municipal wastewater facilities. The maximum daily volume of septage was almost 5 times the average daily volume based on one year's observations at three municipal treatment plants. In Europe and the United States, septage handling varies considerably from one municipality to another. Usually the septage is either added directly to the treatment plant inlet, to the sewer upstream from the treatment plant or directly to the sludge treatment facility at the municipal treatment plant. Germany has developed guidelines covering process as well as management aspects that seek to minimize operational problems. In Norway it is customary to add septage directly to the sludge handling facility of a municipal treatment plant. Pretreatment or anaerobic digestion or lime stabilization are usually required. Careful engineering evaluations must be made to avoid difficulties caused by sludge return liquor to the wastewater treatment plant and odor problems.
W85-05204

DISPOSAL AND UTILIZATION POSSIBILITIES OF SEPTAGE,
National Board of Waters, Helsinki (Finland). Office for Water Supply and Sewerage.
J. Puolanne.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 167-173, 1 Fig.

Descriptors: *Wastewater treatment, *Finland, *Septic wastewater, *Sludge thickening, *Sludge disposal, *Wastewater disposal, *Rural areas, *Landfills, *Liquid sludge, Wastewater, Sludge drying, Sludge utilization, Wastewater renovation, Soil amendments, Land disposal, Dewatering, Sanitary landfills, Liquid wastes, Sludge, Domestic wastes.

The climatic and geographic conditions, quantity and quality of septage and the high water pollution control objectives account for the septage problems encountered in Finland. Regulatory measures include the restriction of disposal on sanitary landfills or underwater sludge, specifications for soil injection, and guidelines for the application of liquid or frozen sludge to selected sites. Dewatered sludge may be applied to sanitary landfills. Farmers may practice on-site septage disposal by the spreading of liquid slurry by farm equipment. For sparsely populated rural areas, mobile dewatering containers or lime stabilizing dewatering equipment are recommended. More work on the design and operation features of septage handling alternatives is still required.
W85-05205

PRINCIPLES OF COMPOSTING,
Helsinki Univ. (Finland). Dept. of Microbiology.
For primary bibliographic entry see Field 5E.
W85-05206

TESTING OF BIOLOGICAL (COMPOSTING) TOILETS AND PRACTICAL EXPERIENCES IN NORWAY,
Norges Landbrukshoegskole, Aas. Inst. for Georesources and Pollution Research.
O. Molland.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 191-206, 8 Fig, 2 Tab, 5 Ref.

Descriptors: *Toilets, *Composting, *Solid wastes, *Waste disposal, *Domestic wastes, *Biological toilets, Water closets, Sludge, Waste paper, Biological degradation, Liquid wastes, Evaporation, Water pollution control, Rural areas, Norway, Sweden.

The biological toilet which does not use water is a sewer-less system where excess liquid is evaporated and solid materials are decomposed to a soil-like and hygienically safe compost. Since the capacity and function of the various models of biological toilets varies widely, the pollution authorities in Sweden and Norway have introduced approval tests for toilets. Of the 7 biological toilets tested for all-year houses, 3 were approved while 9 out of 13 for cabins were approved. The capacity for water evaporation of the toilets varies from 2 to 5 persons for toilets used in all-year houses and from 2 to 8 for toilets used in cabins. Of the toilets approved for marketing, all first required modifications. The most common problems were the water evaporation capacity, emptying of solid wastes, complicated instructions, and care and maintenance, and leakage. Of the large toilet models, the inclined-floor type did not function satisfactorily and could not be recommended for continuous use. The carousel toilet features four chambers which may be rotated to expose a new chamber when one chamber is filled. The Camo-do toilet operates with a bucket that is tilted and emptied into a larger tray when filled. All small toilets must be equipped with a ventilation fan, heating element and a mechanical mixer.
W85-05207

BARK CHIP DECOMPOSITION LATRINES,
Kymi Provincial Environmental Conservation Bureau, Kouvola (Finland).
J. Louvo.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 207-226, 1 Fig.

Descriptors: *Latrines, *Composting, *Bark, *Finland, *Domestic wastes, *Decomposition, *Waste disposal, *Liquid wastes, Biodegradation, Feces, Urine, Animal wastes, Odor, Food-processing wastes, Microbial degradation, Solid wastes.

Bark is used as a covering substance and imparts a pleasant odor while serving to absorb urine in latrines. Bark chip latrines have two containers, one placed on top of the other. The one on top has perforations so the urine trickles into the lower container. After each use the waste is covered with bark chips. The waste containers must be emptied into the primary composting container well before it is filled up. After 2-6 weeks in the primary composting chamber, the waste is transferred to the secondary composting racks. Another latrine covering medium contains a set of living microorganisms dried and spored in it. The biological covering-substance latrines do not give sufficient decomposting of the wastes. The present covering-substance latrines show drawbacks in capacity, urine evaporation, transport of wastes, and inability to be easily emptied. A ping-pong ball idea for a covering substance is being studied as a substance which wastes will stick to, decompose and then fall off. This kind of inactive medium requires a stirrer, heating unit, and aeration device in the latrine. A microprocessor controls and regulates moisture and temperature in the prototype latrine. In Finland, the biological dry toilets functioned well in tests at summer cottages. Bark chips used as litter for animal wastes eliminated odors. The Finnish armed forces have successfully used bark chips in large encampment latrines, warm climate latrines, and in isolated shelter conditions and for composting food wastes. The bark latrine toilet may spread less viruses onto bathroom surfaces than conventional water closet toilets.
W85-05208

PACKAGE WASTE WATER TREATMENT PLANTS,
Ekofinn Oy A.B., Lahti (Finland).
A. Salokangas.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 227-237, 5 Fig.

Descriptors: *Rural areas, *Wastewater treatment, *Wastewater facilities, *Wastewater management, *Suburban areas, *Package treatment plants, Water law, Municipal wastes, Wastewater, Maintenance, Waste storage, Biological wastewater treatment.

Package treatment plants are units fabricated of plastic, concrete, or steel elements which do not constantly contain maintenance personnel. In rural areas, package treatment plants should be suitable for private houses, isolated small communities, country schools, country hospitals or boarding houses, restaurants, seasonal campsites, toilet wastes from industrial establishments, farms, service stations with cafeterias and small scale food stuff industry. The package treatment plant should feature sludge storage capabilities, centralized control with the aid of alarm systems, simple control and adjustment processes and educated maintenance people. Public relations and information for developing user's attitudes for the package treatment plant would be required. Also essential for the acceptance of package treatment plants are changes in water laws, clearer definitions of state and municipal responsibilities, development of municipal control, operation and maintenance of package treatment plants and education of experts, operation and maintenance personnel.
W85-05209

PRACTICAL EXPERIENCES ON PACKAGE TREATMENT PLANTS,
National Swedish Environment Protection Board, Solna.
A. Lind.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 239-254.

Descriptors: *Wastewater treatment, *Package treatment plants, *Biological wastewater treatment, *Comparison studies, *Chemical treatment, *Biological membranes, *Wastewater facilities, *Waste management, Septic tanks, Waste disposal, Scandinavia, Phosphorus removal, Organic matter,

Wastewater disposal, Biofilters, Infiltration, Sand filters.

In the Nordic countries many studies have been conducted on package treatment plants in the last 10 years. In package plants the available treatments include septic tank, biological treatment with aerobic units, biological-chemical treatment, and chemical treatment. From the results of studies which tested function, reliability of service, attendance requirements, and reasons for breakdowns, it was concluded that plants with biological processes operating on the basis of fixed biofilms have major advantages compared to other methods. Fixed biofilm processes exist in biofilter and biodisc. This method is less sensitive to variations in hydraulic and pollution load. The thickness of the biofilm can adjust to the supply of organic matter in the sewage and recover rapidly after periods of disturbances or periods with no load. Biofilm sludge displays good sedimentation qualities and requires no return pumping of sludge. For plants servicing less than 75 people, infiltration and sand filter trenches are recommended. However, it should be noted that sand filter trenches give low reductions of phosphorus.
W85-05210

SUITABILITY AND HYDRAULIC CAPACITY OF DIFFERENT SOILS,
RSE, Inc., Madison, WI.
R. J. Otis, and D. L. Hargett.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 257-272, 6 Fig, 3 Tab, 8 Ref.

Descriptors: *Wastewater treatments, *Septic tanks, *Soil types, *Soil properties, *Soil porosity, *Permeability coefficient, *Wastewater disposal, *Soil physical properties, Soil texture, Land disposal, Soil water, Soil horizons, Moisture tension.

The physical properties of different soils are discussed to evaluate their performance for use in wastewater disposal systems such as septic tank-soil absorption systems commonly used in unsewered areas. Aeration and drainage of soil are closely related to soil texture. Soil structure affects the soil's permeability and also influences the direction of water movement. The basic soil structures are columnar, prismatic, angular blocky, subangular blocky, platy, and granular. Soils with higher bulk density tend to be less permeable than soils of the same texture with lower bulk density. The mineralogy of the clay particles in soil can strongly influence permeability. The arrangement and number of soil horizons in a soil profile may affect permeability and water movement. The gravitational and matric potentials of soil are components of the total soil moisture potential which affects the adsorption of wastewater by the soil. Water movement in soil is dependent on hydraulic conductivity which can change dramatically with changes in soil moisture tension. Soil layers of varying pore-size distributions and permeability may interfere with vertical water movement in both the saturated and unsaturated phases. The recommended application rates (cm/day) of wastewater in conventional systems were 3.2-4.0 for coarse to medium sand, 2.5-3.2 for fine and loamy sand, 2.1-2.5 for sand and porous loam, 1.4-2.1 for loam and silt loam, 0.4-1.0 for clay loams and 0-0.6 for clays.
W85-05211

SOME ASPECTS ON REDUCTION OF PHOSPHORUS IN SOIL TREATMENT SYSTEMS,
Lund Inst. of Tech. (Sweden). Dept. of Environmental Engineering.
P. Nilsson.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 273-290, 16 Fig.

Descriptors: *Phosphorus removal, *Wastewater treatment, *Soil filters, *Wastewater disposal, *Biological wastewater treatment, *Adsorption, *Chemical treatment, *Physicochemical treatment, *Sand filters, Phosphorus, Septic tanks, Soil treatment, Domestic wastes, Biofilters, Flocculation, Separation techniques.

Sand filters differ from soil infiltration sites in that they have a defined volume of filter media, a known media substance and an outlet that goes to a surface water. In Scandinavia, the input of P from wastewater into a soil treatment system is about 2.5 g/person/day. The reduction of P in septic tanks is usually very low. Orthophosphorus accounts for 75-100% of the P in septic tank effluent. P is removed physically by filtration, biologically by the growth of bio-mass in filter media, and chemically by the creation of microflocs which can be filtered, by the adsorption of P to the surface of filtermedia particles or by direct precipitation. A three-step pretreatment of wastewaters helps to lower the concentration of P in the effluent. The IVL Institute of Sweden studied an Al(OH)3 sludge and granulated coal slag for P removal. The granulated coal slag was very soon inactivated due to biological growth. A fullscale sand filter bed with layers of Al(OH)3 sludge was operated in a small village called Bunn for 80 permanent residents and 30 summer residents. Results after 1 yr showed a 90% P removal.
W85-05212

REDUCTION OF NITROGEN,
Sveriges Lantbruksuniversitet, Uppsala. Institutionen foer Mikrobiologi.
M. Pell, and H. Ljunggren.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 291-308, 5 Fig, 3 Tab, 27 Ref.

Descriptors: *Nitrogen removal, *Sand filters, *Wastewater treatment, *Nitrification, *Soil filters, *Microbial degradation, *Biological wastewater treatment, *Denitrification, Nitrogen, Septic tanks, Nitrates, Soil treatment, Wastewater renovation, Bacteria, Pilot plants, Filters, Wastewater disposal, Nitrites, Ammonia, Nitrogen compounds.

Nitrogen-transforming processes were investigated in a newly started pilot sand filter and in two previously loaded columns. To attain better control over the water parameters, artificial sewage water was added after a 24-hr period of pretreatment in a septic tank. The pilot sand filter was loaded with 6.7 cm/day for 100 days, followed by 13.3 cm/day for 25 days. The columns were loaded with 10 cm/day and 20 cm/day, respectively, for 203 days. A complete steady-state nitrification was attained in the pilot sand filter after 45 days of operation. The nitrifying bacteria continued to increase in number for another 25-55 days. Though the denitrifying bacteria were present in high numbers and constituted a considerable fraction of the total bacterial population, a nitrogen reduction of only 17% was observed. When the loading rate was doubled, the nitrification was inhibited and the total bacterial number decreased, but the nitrate reduction increased to 51%. In order to enhance the nitrogen reduction, the columns were constructed with two separate nitrification-denitrification processing steps. One column reached nitrogen reduction exceeding 60% for the whole period of the operation; the other reduced more than 50% of nitrogen for over two months. (Author's abstract)
W85-05213

REDUCTION OF ORGANIC MATTER WITH FOCUS ON THE CLOGGING PHENOMENON,
Sveriges Lantbruksuniversitet, Uppsala. Institutionen foer Mikrobiologi.
M. Pell, and H. Ljunggren.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 309-327, 1 Fig, 4 Tab, 25 Ref.

Descriptors: *Wastewater treatment, *Organic matter, *Organic compounds, *Biological wastewater treatment, *Soil filters, *Hydraulic permeability, *Bacteria, *Wastewater composition, Wastewater renovation, Septic tanks, Biodegradation, Infiltration, Hydrolysis, Proteins, Carbohydrates, Starch, Sand filters, Percolation rate.

The influence of wastewater quality, especially its content of organic matter, on the clogging mechanisms and the hydraulic capacity of infiltration systems was investigated. The active bacterial population and its possible adaptation to various compositions of wastewater were also studied. Small columns packed with sand were loaded once a day with an artificial septic tank effluent containing different concentrations of protein, starch or fat. Six columns loaded with protein-rich water, ranging in COD from 100 mg/liter to 3200 mg/liter, gave a straight-line relationship, showing that if high concentrations were dosed, larger amounts of organic matter could be taken by the surface before ponding. No adaptation of the bacterial population to the quality of water loaded on the columns was found. The highest number of proteolytic bacteria was found in the surface layer, while fat- and starch-hydrolysing bacteria were most numerous 10 cm below the surface. A large number of isolates of proteolytic bacteria also had the capacity to hydrolyse fat and starch. The interpretation is that there is no need for the creation of a specialized bacterial population when these water qualities are used. (Arthor's Abstract)
W85-05214

REDUCTION OF PATHOGENIC MICROORGANISMS IN SOIL INFILTRATION SYSTEMS,
National Bacteriological Lab., Stockholm (Sweden).
T. A. Stenstrom.
In: Proceedings of the Internationl Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 329-344, 5 Fig, 3 Tab.

Descriptors: *Pathogens, *Wastewater treatment, *Adsorption, *Separation techniques, *Filtration, *Soil filters, *Sand filters, Feces, Bacteria, Salmonella, Enteric bacteria, Coliforms, Infiltration, Ionic strength, Filters, Pathogenic bacteria, Filter media, Wastewater.

The number of bacteria in feces is from about one times 10 to the 10th power to one times 10 to the 12th power bacteria per g. In viral infections, the number of excreted viral particles may exceed 10 to the 6th power viral particles per g. An initial dilution and die-off of some of these pathogens will occur in wastewater. Although pretreatment of wastewater before soil infiltration will reduce the number of fecal microorganisms to a certain extent, it may affect the efficiency of the sand filtration due to partial clogging and a concentration of bacteria in the surface layer. By extending the adsorption surface by using finer grain sizes, a better reduction of microorgansims will be achieved. If the ionic strength of the filter media is lowered, the organisms may desorb. The electrostatic effects of adsorption may also be influenced by the composition of the sand. Al, which is used as a flocculent in water treatment, is part of the crystal gitter of some normal sand minerals. Experiments with 100% muscovite gave a very good adsorption of Salmonella. However, this effect is reduced with time due to shielding.
W85-05215

SHORT TERM AND LONG TERM EFFECTS ON GROUNDWATER BY WASTEWATER INFILTRATION IN SUBSOIL SYSTEM,
National Swedish Environment Protection Board, Solna. Research Dept.
U. v. Bromssen.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of

Technology, Finland. 1984. p 345-352, 2 Tab, 7 Ref.

Descriptors: *Wastewater treatment, *Soil filters, *Septic tanks, *Infiltration, *Phosphorus, *Groundwater pollution, *Eutrophication, *Fate of pollutants, Sand filters, Nitrogen, Models, Organic compounds, Domestic wastes, Water pollution control, Suspended solids, Path of pollutants, Detergents, Iron, Chlorine, Boron, Biological oxygen demand.

The reduction of P, N, organic compounds, suspended solids, and microbial organisms in septic tank subsoil systems serving households of 4-5 persons was examined. A risk assessment for groundwater pollution by such systems and the possibility of eutrophication of nearby watercourses in rural areas are also discussed. Soil close to ground surface with high Al and Fe oxide content gives better P retention. The retention of P in Sphagnum peat is less than in non-organic sand or moraine. A slurry of Al(OH)3 gave 90% reduction of P after 1 yr when mixed in sand filter beds. A microbial denitrification process gives N reductions of 67-70%. The reduction of BOD is usually 90-97% while the reduction of suspended solids ranges from 85-90%. Reduction of microorganisms after passage of 0.5-0.8 m of unsaturated soil and the clogging mat at the infiltration surface yields about 100-fold reduction. To protect groundwater from wastewater infiltration, wells must be surrounded by a protection zone in which the location of septic tanks is prohibited. Levels of N, P, Cl, B, Fe and detergents may increase in groundwater located near soil infiltration systems. A model has been developed to calculate critical limits for P in lakes and streams. For lakes, the P content is not recommended to exceed 25 micrograms total P/liter if the N/P ratio is > 10. Usually about 1.5 sq km of discharge area is required for every family's sand filter bed.
W85-05216

SUBSURFACE ADSORPTION SYSTEMS - FROST PROBLEMS AND PREVENTION OF FROST,
Norges Landbrukshoegskole, Aas. Inst. for Georesources and Pollution Research.
T. Osteraas.
Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 355-364, 7 Fig.

Descriptors: *Septic tanks, *Soil filters, *Frost prevention, *Clogging, *Frost, *Frost protection, *Sand filters, *Freezing, Wastewater disposal, Wastewater treatment, Absorption, Frost heaving, Frost thrusting, Heat transfer, Snow cover, Soil adsorption capacity, Soil temperature, Septic wastewater.

Frost can cause damage to subsurface adsorption systems by cracking pipes and tanks or clogging pipes and soil by frozen wastewater and sludge. Many frost problems in standard house sewers can be avoided if construction is done properly. Frost in the effluent pipe can also be avoided by avoiding stagnation areas during construction. To prevent freezing of the adsorption fields in areas with extreme frost, heat conservation action such as insulation or heat supply may be necessary. Laboratory tests carried out at GEFO show that frozen absorption fields under certain circumstances will work even when the temperature in the sand is below freezing. The risk of freezing temperatures penetrating the backfill to the infiltrative surfaces can be calculated if the frost quantity, annual mean temperature, snow cover thickness and quality, backfill thickness and thermal diffusion and heat capacity, and heat transfer from wastewater to the adsorption system are known. When these parameters are known, the need for insulation material and electrical heat wires can be assessed.
W85-05217

DESIGN AND CONSTRUCTION OF CONVENTIONAL AND MOUND SYSTEMS,
RSE, Inc., Madison, WI.
R. J. Otis.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ of Technology, Finland. 1984. p 365-399, 6 Fig, 12 Tab, 16 Ref.

Descriptors: *Wastewater treatment, *Soil treatment, *Design criteria, *Site selection, *Adsorption, *Permeability coefficient, *Trenches, Septic tanks, Sand pits, Wastewater facilities, Soil profiles, Wastewater disposal, Construction methods, Topography, Soil properties.

In order to prevent groundwater contamination, careful site selection for wastewater treatment systems should be carried out. Client contact must be made to determine the location and description of the lot, whether the use will be domestic, commercial or industrial, and the volume and characteristics of the wastewater. A preliminary evaluation should be made of available resource data of the area and of records of onsite systems in surrounding areas. Field testing of the intended area of the treatment system should include examinations of topography and landscape feature, soil profiles and hydraulic conductivity. If necessary, site suitability for evaporation or discharge to surface waters should also be evaluated. All data collected should be compiled into a usuable form. Trenches are usually more desirable than beds due to increased sidewall adsorption, ease of construction and less excavation disturbances. Shallow systems are preferred over deep systems where there are problems of freezing. Alternating fields may extend the life of an adsorption system. The three basic methods of wastewater distribution (gravity flow, dosing and uniform application) each have their own advantages and disadvantages. The selection of a distribution method depends on whether improved adsorption or improved treatment is the objective. The mound system offers adsorption into the more permeable topsoil, less restrictive clogging mat, and minimum construction damage. A mound system is usually preferrable in areas with shallow water tables. The mound should be oriented relative to the bedrock rather than the ground surface.
W85-05218

SCANDINAVIAN GUIDELINES AND TRAINING PROGRAMS FOR DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF SEWERAGE TREATMENT SYSTEMS IN RURAL AREAS,
Norges Landbrukshoegskole, Aas. Inst. for Georesources and Pollution Research.
T. Osteraas.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 403-407, 1 Fig.

Descriptors: *Wastewater treatment, *Wastewater management, *Rural areas, *Scandinavia, *Wastewater disposal, *Education, *Training, *Standards, Regulations, Norway, Sweden, Water law, Water pollution control, Absorption, Sand filters, Soil filters.

When the guidelines for wastewater treatment systems in Norway and Sweden were updated recently, the goal was to reduce differences in the existing laws and regulations as much as possible between the two countries. A cooperative three-year research program among the Scandinavian countries produced a report in 1983 upon which the new guidelines are based. A Scandinavian reference group was established with the Norwegian State Pollution Control Authority as a secretariat to perform the practical work of the guidelines. The main chapters of the new guidelines will be on on-site treatment methods, types of equipment used in construction, and operation and maintenance of the systems. To obtain correct sizing of the absorption field, the guidelines prescribe the use of a Md/So-diagram. A similar diagram has been designed for the evaluation of sand for sand filters. In Norway the Ministry of Environment and the State Pollution Control Authority have established training programs for the technical staff at the country and community level and for construction engineers of wastewater treatment sytems.
W85-05219

ONGOING AND RECENT RESEARCH ON ON-SITE TREATMENT AND DISPOSAL METHODS IN SWEDEN,
National Swedish Environment Protection Board, Solna. Research Dept.
U. v. Bromssen.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 409-418.

Descriptors: *Standards, *Regulations, *Wastewater treatment, *Wastewater disposal, *Infiltration, *Groundwater pollution, *Sweden, *Research priorities, Soil treatment, Absorption, Soil bacteria, Pathogens, Path of pollutants, Fate of pollutants, Septic tank, Wells, Water pollution control.

The National Swedish Environment Protection Board (SNV) has numerous ongoing and recent research projects for the protection of groundwater resources from pollution by on-site wastewater treatment and disposal systems. Much of the research is funded by the Swedish Infiltration Project started in 1977. Past projects determined the characteristics of sewerage water, and the extent of pollution of groundwater from on-site systems. Laboratory as well as field studies were conducted. Some ongoing studies financed by SNV deal with sand filter trenches, microorganisms in sewage infiltration systems, and the transport of pollutants in groundwater. Projects carried out from 1977 to 1982 studied a pilot scale denitrification sand filter, adsorption of heavy metals into Swedish soils, pond infiltration as a final step for municipal treatment plants, development of additives to enhance P adsorption, survival and transport of microbial pathogens and indicators in soil and groundwater, models of pollutant transport in groundwater, improvement of big three-chamber septic tanks, and critical limits of P in lakes and streams. The Swedish Infiltration Project ended in June 1982 but publications from the project will continue until 1984, culminating in the issuance of a new guidelines manual for infiltration systems and the protection of groundwater wells.
W85-05220

RESEARCH OF ON-SITE WASTEWATER TREATMENT AND DISPOSAL IN FINLAND,
National Board of Waters, Helsinki (Finland). Technical Research Office.
M. Melanen.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 419-425, 2 Tab, 2 Ref.

Descriptors: *Finland, *Wastewater treatment, *Wastewater disposal, *Research priorities, *Septic tanks, *Soil treatment, Regulations, Composting, Package treatment plants, Wastewater renovation, Project planning, Wastewater management.

In Finland, the amount of funds allocated to the study of on-site wastewater treatment and disposal has been modest so far. In 1981, some 150-200 thousand Finnish marks were used in research and development projects dealing directly with on-site wastewater treatment. Roughly one million Finnish marks were used in projects which dealt with on-site treatment and disposal. Some general topics of these projects were policy and regulations, sewerage and septic tanks, composting and package treatment plants and soil as a renovating medium for wastewaters. In the 1980's, the areas targeted for further research include toilets, package treatment plants, soil absorption systems, septic and closed tanks, guidelines for construction, operation and maintenance of on-site systems and develop-

ment of monitoring systems for package treatment plants.
W85-05221

ONGOING AND RECENT ON ON-SITE TREATMENT AND DISPOSAL METHODS IN THE U.S.A.,
Washington Univ., Seattle. Dept. of Civil Engineering.
R. W. Seabloom.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 427-440, 9 Fig, 2 Ref.

Descriptors: *Wastewater treatment, *Wastewater disposal, *Research priorities, *United States, *Soil treatment, *Waste disposal, *Data collections, Sand filters, Evapotranspiration, Septic tanks, Trenches, Waste management, Data transmission, Soil filters, West Virginia, Oregon.

Selected research projects either underway or already completed in the United States cover the following areas of on-site wastewater treatment and disposal methods: construction methods, composting toilets, water conservation, priority pollutants, fate of toxins, fate of N and other inorganics, septage, pressure distribution systems, pressure sewer design modifications, and H2O2 rejuvenation. The United States Environmental Protection Agency has established a national clearinghouse at West Virginia University, Morgantown which collects and disseminates small community wastewater technology information. The Oregon On-Site Experimental Systems Program has conducted an extensive study of the practical application of sand filters, evapotranspiration and evapotranspiration absorption systems, steep slope systems, groundwater control systems, and several other novel approaches to solve specific site constraints which preclude the use of conventional septic tank adsorption systems. Some of the more pertinent studies of this project which ended in 1982 covered recirculating and intermittent sand filter systems, perimeter drain dewatering systems in wet soils, deep seepage trenches in soils with slow and very permeabilities, seepage trenches on steep slopes, disposal trenches in soil shallow to weathered and fractured bedrock, and pressure distribution systems in soils with shallow groundwater.
W85-05222

PROCEEDINGS OF THE 37TH INDUSTRIAL WASTE CONFERENCE MAY 11, 12, AND 13, 1982, PURDUE UNIV., WEST LAFAYETTE, INDIANA.
Ann Arbor Science Publishers, Ann Arbor, Michigan, 1983. 952 p.

Descriptors: *Industrial wastewater, *Conference, *Wastewater treatment, Chemical wastes, Food-processing wastes, Metal-finishing wastes, Textile mill wastes, Tannery wastes, Oil wastes, Explosives, Land disposal, Pharmaceutical wastes, Agricultural wastes, Pulp wastes, Paper wastes, Hazardous materials, Toxicity, Powerplants, Coal, Coke, Industrial wastes.

This proceedings volume contains 77 papers relevant to wastewater treatment and pollution control. The papers are classified according to the following general categories: chemical wastes, food wastes, metal wastes, textile wastes, tannery wastes, plating wastes, oil wastes, explosive wastes, land disposal, pharmaceutical wastes, agricultural wastes, paper wastes, hazardous and toxic wastes, coal, coke and power plant wastes, refinery wastes, laws and regulations, physical/biological systems, miscellaneous wastes.
W85-05224

PACT/WET AIR REGENERATION OF AN ORGANIC CHEMICAL WASTE,
Zimpro, Inc., Rothschild, WI.
M. R. Rollins, C. E. Ellis, and C. L. Berndt.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 1-12. 11 Fig, 6 Tab, 14 Ref.

Descriptors: *Organic wastes, *Activated sludge process, Chlorinated hydrocarbons, Chemical wastes, Biological oxygen demand, Chemical oxygen demand, Organic carbon.

Pilot studies, to demonstrate application of PACT and wet air regeneration (WAR) to the treatment of an organic chemical waste, are described. The pilot study spanned 5 months of onsite pilot-plant operations, using 4 continuous-flow pilot plants. Three of the pilot plants were PACT systems; one was operated in an activated sludge mode without secondary solids handling. During the 5-month study period, each pilot unit treated nearly 21,000 liters of wastewater. The PACT process provided better removals of COD, TOC, BOD sub 5, color, chlorinated hydrocarbons and phenol than did activated sludge. Over the range of mixed liquor volatile carbon concentrations of 0-13 g/l the best PACT/WAR performance was observed at the highest carbon concentrations and at the lowest X/m values. Chlorinated hydrocarbon removals by the PACT/WAR process were excellent at all times. Influent concentrations ranging 5-100 mg/l had little effect on chlorinated hydrocarbon removal. Oxidation of chlorinated hydrocarbons during the WAR of the spent carbon was confirmed. PACT/WAR performance at 6-7 C aeration temperature remained stable and was superior to activated sludge at 22-29 C. Removals of BOD sub 5, COD and TOC in the low-temperature PACT/WAR pilot plant were greater than 98% of the influent concentration.
W85-05225

WASTEWATER TREATMENT OF A PHTHALATE PLASTICIZER, ETHANOLAMINE AND MORPHOLINE MANUFACTURING PLANT: A CASE STUDY,
National Environmental Engineering Research Inst., Nagpur (India). Industrial Wastes Div.
P. V. R. Subrahmanyam, S. N. Khadakker, T. Chakrabarti, and B. B. Sundaresan.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 13-20. 2 Fig, 5 Tab, 15 Ref.

Descriptors: *Wastewater treatment, *Activated sludge process, Wastewater facilities, Biochemical oxygen demand, Chemical wastes, Organic wastes.

In-plant surveys were undertaken of biological treatability of combined wastewater from a factory manufacturing phthalate plasticizers, ethanolamines and morpholine. Data were presented on wastewater volume, BOD and COD loads discharged per 1000 kg of the different products made. Organics in morpholine wastewater exerted COD, but not BOD. The combined wastewater exerted an average BOD sub 5 of 1420 mg/l with a BOD load of 110 kg/l day. Whenever morpholine wastewater formed a part of the combined wastewater, the BOD-to-COD ratio was low. Plasticizer and morpholine sections produce sludge and slurry that are to be segregated, concentrated and disposed by burning. Bench-scale activated sludge treatment studies of the combined wastewater indicated that the BOD could be reduced by 96% at a loading of 0.16 kg BOD/kg MLSS/day, and SRT of 18 days. The sludge synthesis and endogenous respiration coefficients a and b were 0.56 kg/kg BOD removed and 0.014/day, respectively. The treated effluent at 0.26 loading was nontoxic to Lebistes reticulatus for 120 hr. Based on the treatment flowsheet prepared by NEERI, a full-scale wastewater treatment plant has been constructed, the cost of which was about 1.2% of the total capital cost.
W85-05226

ROTATING BIOLOGICAL CONTRACTORS TREATING COMBINED DOMESTIC AND CHEESE-PROCESSING WASTEWATERS,
Kirkham, Michael and Associates, Omaha, NE.
M. J. Hammer.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 29-38. 8 Fig, 6 Tab.

Descriptors: *Food-processing wastes, *Biochemical oxygen demand, *Wastewater treatment, Shock loads, Biological wastewater treatment.

The two-stage RBC system processing combined domestic and cheese-manufacturing wastewater at New Man Grove, in east-central Nebraska, provides excellent treatment at the present hydraulic and organic loads that are approximately 93 and 25% of the design values, respectively. The effluent BOD was less than 11 mg/l and suspended solids concentration was less than 20 mg/l for 90% of the time. The system is able to process maximum probable shock loads from accidental spilling of whey without prolonged loss of treatment efficiency. The effect is deterioration of the effluent quality to an average BOD of approximately 60 mg/l for 2 days. However, with only one shock load per week, resulting from the worst anticipated nonrepetitive spillage of whey, the effluent quality is expected to meet the specified average monthly BOD and suspended soilds limits of 30 mg/l and the maximum average weekly concentrations of 45 mg/l. The current arrangement of dividing the biological disks equally between the first and second stages does not provide optimum use of the contractor surface area. Based on curves drawn from the plant evaluations, the allowable BOD load on the rotating biological contractor system could be increased about 50% for an effluent quality of 30 mg/l BOD by providing 75% of the disk area in the first stage and only 25% in the second stage.
W85-05227

ANAEROBIC TREATMENT KEY TO POLLUTION CONTROL AND SOLIDS DISPOSAL WITH ENERGY RECOVERY FOR A FOOD PROCESSOR,
ADI Ltd., Fredericton (New Brunswick).
R. C. Landine, A. A. Cocci, T. Viraraghavan, and G. J. Brown.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 47-50. 1 Ref.

Descriptors: *Food-processing wastes, *Solid waste disposal, Manure, Chemical oxygen demand, Biochemical oxygen demand, Volatile solids, Potatos, Feedlot wastes.

A large potato processing plant needed to install secondary treatment. The company was also having difficulties in disposing of a large quantity of filter cake, other potato waste solids and manure from its feedlot where cattle were being fed screenings and some other potato wastes. The proposed waste treatment facilities entail continued trucking of screenings solids to the company's feedlot to form part of the feed ration for the cattle. The feed truck could carry manure supernatant (only) on its return trip for treatment in the bulk volume fermenter (BVF) system. This liquid manure stream would no longer present a pollution threat to the nearby stream, but will enhance biogas generation and receive a high degree of treatment prior to discharge into a large river. The biogas can be recovered and supplied to the process boilers where it displaces approximately 20,000 liter/day of imported oil when operating under design loading conditions. This design requires a very large load (80,000 kg/day) of chemical oxygen demand (COD), requiring secondary treatment; however, no difficulty was foreseen in metting effluent limits. The waste treatment facilities involve two-stage anaerobic treatment followed by single-stage aerobic treatment. The basic design data are: flow, 8000 metric ton/day; COD, 80 metric ton/day; biochemical oxygen demand (BOD), 40 metric ton/day; SS, 40 metric ton/day; and volatile suspended solids (VSS), 35 metric ton/day.
W85-05229

WATER USAGE AND WASTEWATER STUDY FOR A SPECIALTY FOOD PROCESSING COMPANY,
Van Kirk Engineers, Los Altos, CA.
F. N. Van Kirk.

In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 51-60. 2 Fig, 11 Tab.

Descriptors: *Wastewater treatment, *Food-processing wastes, Organic carbon, Suspended solids, Biochemical oxygen demand, Oil, Grease.

The water usage associated with the processing and packing of various specialty food items and the pollutional load per product resulting from these operations were determined. All of the water used for cleanup in the process room flows to the industrial waste sump. Although a good effort is made to keep fruit and vegetables from entering the sump, considerable amounts reach the sump. Other water uses include compressor cooling water, boiler makeup, water used for brines and vinegar, and domestic and irrigation uses. A tabulation of the average total amount of water used indicated that the greatest amount was used for cleanup (average approximately 37,500 gallons per day). The next largest usage was for leaching at approximately 23,000 gallons per day. The third largest usage was on the retail and food service lines. The usage per operation (boot tank, product washer, Solbern filler) on each of these lines was fairly constant, ranging 9200-9800 gallons per day. Samples of wastewater discharged to the sewer as well as samples of process wastewater were collected and analyzed for TOC, TKN and SS because they are the constituents, plus flow, on which the city is bases its sewer use charges for critical industrial users and canneries. TOC and related BOD concentrations were quite high, typical of food processing waste. TKN was low as was the O and G content. SS was low considering the amount of solids flowing to the industrial waste sump, indicating that the screen at the industrial waste sump is removing the solids.
W85-05230

SPRAY IRRIGATION OF CITRUS WASTE,
Bio Engineering Sciences, Inc., Orlando, FL.
C. W. Sheffield, and M. D. Sims.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 61-69. 3 Fig, 2 Tab.

Descriptors: *Citrus fruits, *Wastes, *Spray irrigation, Biological oxygen demand, Suspended solids, Hydraulic loading, Surface drainage, Hydraulic models, Groundwater.

The problems associated with spray irrigation of citrus waste are reviewed. The typical waste loads from a single-strength citrus plant include: 5-100 gallons per box processed; 100-1000 lb/day BOD combined flow, no treatment; 100-400 lb/day BOD wash water only; 60-200 mg/l suspended solids, combined flow, no treatment; and 1000-2000 mg/l total solids, combined flow, no treatment. The typical waste loads from citrus concentrating plants include: 200,000-5,000,000 gal/day volume of waste; 20-500 gallons of water per box processed; less than 100 mg/l BOD in weak water (cooling water); less than 3000 mg/l BOD strong waste, no treatment; less than 100 mg/l weak waste suspended solids; less than 300 mg/l strong waste suspended solids; less than 100 mg/l weak waste total solids; 400-4000 mg/l strong waste total solids; and pH 4-11. The characteristics of citrus wastes tends to compound the normally difficult problem of analyzing the hydrogeology of a site and determining allowable hydraulic loading rates and impact on groundwater levels and movement. The hydraulic model must be adjusted to account for soil clogging and the varying strength and physical properties of the effluent. The design of most systems will benefit by providing a minimum of 2 separate application areas such that the surface sludge layer can be allowed to dry and oxidize or be scraped and disced to restore infiltration rates on an alternating basis. Temporary storage basins should be provided to direct flows during high-rainfall periods such that excess surface runoff will not occur. Perimeter swales or berms should be provided to prevent runoff as surface clogging occurs.
W85-05231

EFFECT OF HEIGHT ON THE PERFORMANCE OF ANAEROBIC DOWNFLOW STATIONARY FIXED-FILM REACTORS TREATING BEAN BLANCHING WASTE,
National Research Council of Canada, Ottawa (Ontario). Div. of Biological Sciences.
K. J. Kennedy, and L. Van den Berg.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 71-76. 6 Fig, 2 Tab, 11 Ref.

Descriptors: *Food-processing wastes, *Wastewater treatment, Anaerobic bacteria, Methane bacteria, Downflow stationary fixed film reactors.

Downflow stationary fixed-film (DSFF) reactors are capable of high loading rates and high rates of methane production utilizing a variety of wastes and operating conditions. Successful operation of DSFF reactors is based on the immobilization of bacteria, especially the slowly growing methanogens, on a support medium in order to minimize the washout of these bacteria with the effluent. Results obtained over a period of 1.5 years with reactors of the same cross section but of different height are presented. Performance of DSFF reactors during startup and steady-state conditions was affected more by the support surface area-to-volume ratio than reactor height. In order to enhance mixing, DSFF reactors have a liquid volume above and below the packing material. It may be preferable that large reactors be scaled up vertically rather than horizontally so as to maximize the surface area-to-volume ratio.
W85-05232

STEEL WELDING WIRE MANUFACTURER MEETS STRINGENT EFFLUENT AND SLUDGE DISPOSAL CRITERIA,
Reece Engineering, Inc., Clarksville, TN.
R. S. Reece.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 77-83. 6 Fig, 3 Tab.

Descriptors: *Metals, *Sludge disposal, *Effluents, Industrial wastewater, Iron, Copper, Water conservation, Steel, Welding wire.

A steel welding wire manufacturer was able to meet stringent effluent and solid waste disposal requirements by taking a step-by-step approach. After a waste characterization and treatability study was performed, a plan of action was developed which included a water conservation program and phased construction to determine optimum design parameters. The final treatment facility reduced iron and copper concentration in a 65 gal/min rinse water stream to below 5 and 1 mg/l respectively, and neutralized approximately 30,000 gal/month of spent hydrochloric acid and copper plating solutions. Sludges were dewatered to a 50% solids content. Treated rinse water is recycled back to the cleaning and plating process. The combination of water conservation, cooling water recycle and rinse water recycle reduced water consumption by 75%.
W85-05233

METAL INHIBITION OF NITRIFICATION,
Wisconsin Univ.-Milwaukee. Dept. of Civil Engineering.
J. Y. C. Huang, and B. Sheikhdeslami.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 85-93. 7 Fig, 4 Tab, 12 Ref.

Descriptors: *Nitrification, *Inhibition, Heavy metals, Ammonia, Nitrates, Nickel, Chromium, Zinc.

The rate constants of both ammonia oxidation and nitrate formation under various influences of chromium, nickel and zinc are used for evaluating the relative inhibition by the metals. Of the 3 metals investigated, nickel is the most toxic to both ammonia oxidation and nitrate formation, followed by zinc and chromium. Of these 2 steps of nitrification, the former step is more susceptible to inhibition, thus representing the weak link in the nitrification chain. The Hunter-Downs plot was used to characterize the type of metal inhibition on nitrification. The inhibition is neither competitive nor noncompetitive.
W85-05234

GRAVITY FILTRATION FOR REDUCTION OF SUSPENDED METALS IN A LIME PRECIPITATION TREATMENT SYSTEM,
General Motors Corp., Lockport, NY. Harrison Radiator Div.
R. D. Knapp, and E. G. Paulson.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 95-104. 5 Fig, 6 Tab.

Descriptors: *Gravity filters, *Suspended solids, *Metals, Backwash, Heavy metals, Clarified wastewater, Lime, Chromium.

A case history of an installation where filtration was used to upgrade the clarified effluent of a heavy metal removal treatment plant is presented. The Harrison Radiator Division of General Motors Corporation primarily manufactures automotive radiators and air conditioners at the facility located in Lockport, NY, approximately 15 miles north of Buffalo. Typical manufacturing operations include metal formation, assembly, degreasing, washing, chromium conversion coating, and painting. The primary design factors, based on pilot-plant work, included filtration by gravity through unstratified media, simultaneous air-water backwash without media loss, no support gravel, and a maximum driving force of 10 ft of water head. The gravity filter system has demonstrated its ability to reduce heavy metal concentrations to low levels that consistently meet permit limits. The simultaneous air and water backwash has prevented agglomeration of the medium, and the special backwash trough baffle design has prevented medium loss. Calcium carbonate deposition has occurred on the filter medium and can result in operational difficulties. The effects of this deposition can be controlled and studies are underway to determine the most cost-effective way to accomplish this. Much of the success of this system can be credited to adaptability built into the design, particularly in the areas of standby units, control systems, and the medium transport system.
W85-05235

HANDLING OF ALUMINUM FORMING WASTEWATER,
Sverdrup and Parcel and Associates, Inc., St. Louis, MO.
J. C. Carlton, G. R. Aronberg, D. R. Washington, J. K. Goodwin, and E. P. Hall.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 105-117. 13 Fig, 8 Tab.

Descriptors: *Wastewater treatment, *Filtration, *Cooling towers, *Effluents, *Aluminum, Suspended solids, Copper, Zinc, Chromium.

The production processes used in the aluminum forming and can manufacturing industries produce a significant volume of wastewater containing oils and metals. The methods including settling and filtration, cooling towers, and countercurrent rinsing, are used to reduce the amount of wastewater produced. The discharged wastewaters are treated in a variety of ways, including chemical precipitation of metals, pH adjustment, gravity oil-water separation, chemical emulsion breaking, and filtration. The treatment processes used depend on the type, volume and characteristics of the wastewater streams and the disposal of the treated effluent. The effluent discharged from a well-operated treatment facility directly to a receiving stream may contain less than 0.2 mg/l Al, 0.61 mg/l Cu, 0.4 mg/l Zn, Cr 0.47 mg/l, 10 mg/l oil and grease and 10 mg/l suspended solids.
W85-05236

ALUM PRODUCTION FROM ALUMINUM ETCHING WASTES,

Pirnie (Malcolm), Inc., Newport News, VA.
D. A. Cornwell.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 119-126. 4 Fig, 6 Tab.

Descriptors: *Metal-finishing wastes, *Alum, *Aluminum, Metals, Feasibility studies, Aluminum sulfate.

The aluminum finishing industry typically produces 3 waste streams: the concentrated spent etching solution, the rinse water, and a concentrated spent acid solution. A number of processes exist for recovering materials from either the etching solution or from a sulfuric acid electrolyte solution. One integrated process has been developed to recover products from a controlled mix of the 2 wastes. The existing processes include: Bayer process, mutual neutralization, calcium aluminate, zeolite, evaporation-crystallization, ion exchange, and sodium aluminate-aluminate sulfate. These all utilize the spent etch and/or acid solution to produce a reusable or marketable product. All but the integrated process produce significant waste materials requiring disposal. They all require the relatively expensive step of dewatering the aluminum hydroxide. A process was adapted which was developed for use in the water industry in an attempt to produce a marketable aluminum sulfate solution while producing a minimum of waste material and eliminating or reducing the need for a sludge dewatering step. The principle of the liquid ion exchange procedure used on aluminum hydroxide is to extract the aluminum from the solid precipitate by direct contact with a solvent. The solvent consists of 3 components: the extractant is the actual compound in the solvent responsible for selective extraction of the aluminum. A modifier is used to improve extractant solubility in the solvent. The diluent is the organic liquid into which the extractant and modifier are dissolved. A feasibility study concluded that such a procedure was possible.
W85-05237

TREATMENT FOR REMOVAL OF HEAVY METAL AND OIL FROM A PISTON RING MANUFACTURING WASTE,
Black and Veatch, Kansas City, MO.
J. L. Carter, and M. S. Jones.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 127-138. 8 Fig, 16 Tab.

Descriptors: *Metal-finishing wastes, *Wastewater treatment, *Heavy metals, *Oil, Sludge, Chromium, Barium, Lead, Zinc, Acids, Suspended solids.

Ramsey Corporation, at Sullivan, Missouri, manufactures cast iron and steel piston rings. About 160,000 gallons per day of waste is produced containing oil, chromium, lead, barium, zinc, suspended solids, acids and alkalies. Separate treatment is provided for the chrome-containing wastes and for the oil-lead containing wastes. All wastewater is treated in a lagoon system prior to final discharge to a tributary of Wenzel Creek. In 1980, the Missouri Water Pollution Board recommended that the use of the lagoon be discontinued because of failure to comply with its National Pollutant Discharge Elimination System permit. Black and Veatch conducted studies to define Ramsey's waste treatment problems and recommended treatment modifications to ensure meeting the discharge permit. A three-cell basin system was recommended for the treatment of Ramsey's Sullivan plant wastewater. The retention time in the holding basin is the same as that in the lagoon system. There were difficulties in meeting the effluent permit requirements for barium, oil, lead and suspended solids. With the improved removal of oil in the plant, the effluent oil concentrations are below permit requirements. The barium treatment compound is not used. This eliminates barium in the treated effluent. The sludge, containing metals and some oil, is removed in the first cell of the proposed basin system to prevent wind currents from stirring up settled sludge and producing high effluent concentrations.
W85-05238

CASE HISTORY: PRETREATMENT OF TEXTILE WASTEWATER,
Weston (Roy F.), Inc., West Chester, PA.
R. Junkins.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 139-146. 5 Fig, 5 Tab.

Descriptors: *Textile mill wastes, *Pretreatment of water, *Bleaching wastes, Biochemical oxygen demand, Chemical oxygen demand, Oil, Suspended solids, Chromium.

A case study concerning pretreatment of bleachery wastes is presented. Investigative results of a biological approach to wastewater treatment are presented and shown to be effective. The analytical determinations performed included wastewater flow, biochemical oxygen demand (BOD), chemical oxygen demand (COD), oil, total dissolved solids (TDS), suspended solids (SS), pH, ammonia nitrogen, total phosphorus, phenol, sulfide and total chromium. The following sources were identified as major contributors of wastewater from the bleachery: bleaching operations (including scour tank, bleachers and washers); boiler blowdown; ion exchange units (including process water conditions units and boiler feedwater conditioning units); and sanitary system. It is emphasized that due to the variability of textile wastewater characteristics, treatability studies need to be conducted on a case-by-case basis in order to identify and confirm the required design parameters.
W85-05239

TEXTILE DYEHOUSE WASTEWATER TREATMENT: A CASE HISTORY,
Gilbert Associates, Inc., Reading, PA.
C. R. Kertell, and G. F. Hill.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 147-156. 8 Fig, 4 Tab.

Descriptors: *Textile mill wastes, *Wastewater treatment, *Dye industrial wastes, Biochemical oxygen demand, Suspended solids, Color, Alum, Effluents.

An industrial wastewater treatment system has operated successfully at Penn Dye and Finishing Company, Pine Grove, Schuylkill County, Pennsylvania since September 1980. Effluent samples are collected and analyzed on a regular basis in accordance with permit requirements. With only minor exceptions, effluent discharges have complied with all permit limits. Alum can be used to remove residual biochemical oxygen demand (BOD), suspended solids and color from biologically treated textile dyehouse wastewater. The treated effluent has potential for in-plant reuse. Several factors contributed toward producing a successful industrial waste treatment program at Penn Dye and extend beyond the basic system design function, including: an extensive program of preliminary studies which preceded the detailed design of the system and which established reliable design data; obtaining permits as an integral part of the system design, rather than as an isolated act; use of only proven, reliable unit operations and processes in the treatment system design; and commitment of company management and engineering personnel to conduct a successful waste treatment program. Continuing operations and maintenance are critical to any wastewater treatment system, and their importance cannot be minimized.
W85-05240

ENERGY AND MATERIALS RECOVERY OPTIONS FOR THE TEXTILE INDUSTRY,
Argonne National Lab., IL. Energy and Environmental Systems Div.
E. Kremer, B. Broomfield, and L. Fradkin.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 157-161. 4 Fig, 15 Ref.

Descriptors: *Textile mill wastes, *Wastewater treatment, *Dye industrial wastes, Sludge, Anaerobic bacteria, Effluents, Heavy metals.

Nearly half of the textile mills in the United States, excluding mills with low water use, indirectly discharge their wastewater without further treatment; as a result, the organic constituents of these streams pose significant problems for publicly owned treatment works and aquatic life. Those facilities that provide treatment generally use some form of the activated sludge process. On a wet weight basis, the textile industry is second only to the electroplating industry in its production of sludge. The organics discharged consist primarily of sizes, dyes and detergents. Treatment of these constituents provides the basic treatment of any plant's scheme. Size represent the single largest group of chemicals used in the industry. Starch has been the traditional sizing material used, but mills have been increasing the use of synthetic sizes polyvinyl alcohol (PVA) and sodium carboxymethylcellulose (CMC) as a replacement for starch for use on synthetic and synthetic blend materials. The synthetic detergents are divided into hard anionic, soft anionic, nonionic and cationic. The hard anionic types are not as readily biodegraded as the soft anionic types. Facultative anaerobic bacteria, which were able to degrade azo dyes, can be isolated from draining ditches at dyestuff factories. Most of the priority pollutants contained in textile industry effluents are aromatics, halogenated hydrocarbons and heavy metals. The optimal situations for chemcial recovery is the use of RO/UF for a specific process. In the manner, chemicals are recovered in their least contaminated form best suited for reuse.
W85-05241

TREATMENT OF METAL PLATING WASTEWATER WITH A DISPOSABLE ION EXCHANGE MATERIAL,
Indiana State Board of Health, Indianapolis. Div. of Water Pollution Control.
V. Keramida, and J. E. Etzel.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 181-188. 10 Fig, 3 Tab, 11 Ref.

Descriptors: *Wastewater treatment, *Heavy metals, Copper, Nickel, Zinc, Metal plating, Vermiculite.

Multivalent heavy metal ions were removed from simulated acid bath plating liquid wastes by passing the wastes through an unexpanded vermiculite cation exchange bed. The particular vermiculite material used had a particle size in the range of 0.0067-0.0234 in and a CEC of 676-86 meq/100 g of material. The CEC of the vermiculite varied depending on the particular multivalent metal ion present (copper, nickel or zinc), being lowest for zinc and highest for nickel. The vermiculite also functioned effectively to remove mixtures of the three heavy metal ions from waste streams.
W85-05243

MORE ECONOMICAL TREATMENT OF CHROMIUM-BEARING WASTES,
Espey, Huston and Associates, Inc., Austin, TX.
C. R. Taylor, Jr., and S. R. Qasim.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 189-196. 10 Fig, 6 Ref.

Descriptors: *Metal-finishing wastes, *Chromium, Oxygen, Wastewater treatment.

An experimental program was conducted to quantify the stoichometry of the chromium reduction reaction. The objectives were to quantify the oxygen reacting with reducing agent and to show how the stoichometry of the chromium reduction reaction can be proven if the oxygen reactions are considered. A process was designed to treat chrome bearing wastes more economically. Industries that plate metals with chromiun are concerned with the treatment and disposal of very dilute chromium concentrations from rinse baths. Great excesses of reducing agent are consumed by the dissolved oxygen contained in the chromium waste solution. The most common method of pretreatment of chromium containing waste is the reduction of hexavalent chromium to trivalent chrome using sulfur dioxide or one of its salts. A reactor was designed to allow complete oxygen

removal before addition of chemical, for chromium reduction, and to maintain the anoxic condition throughout the experiment. The presence of dissolved and atmospheric oxygen had a significant effect on the amount of reducing agent required to reduce hexavalent chromium to trivalent chrome. Chromium reduction is run at pH 2.0 and the reaction time is relatively fast (10 to 60 minutes) so that atomospheric oxygen does not consume extreme excesses of reducing agent. With the elimination of atmospheric oxygen as an interference, the reduction reaction is accomplished with an equal amount of reducing agent at greater reduction times.
W85-05244

OIL WASTE TREATMENT AND RECLAMATION IN THE AUTOMOTIVE INDUSTRY,
Chrysler Corp., Kokomo, IN. Transmission Plant.
B. D. Harlow, J. W. Hubbell, and T. M. Doran.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 197-202. 2 Fig, 3 Tab.

Descriptors: *Oil wastes, *Reclamation, Industrial wastewater, Aluminum, Emulsions, Wastewater treatment.

Industrial waste treatment can be a costly component of a manufacturing operation. The Chrysler Corporation manufactures die cast aluminum transmission housings and manifolds at the casting plant and assembles the transmissions at the transmission plant in Kokomo, Indiana. The industrial waste treatment plant is required to reduce the concentration of Freon-extractable compounds to less than 50 mg/l prior to discharge to Kokomo's sanitary sewer. In 1978 a program was developed to investigate an emulsion breaker/alum treatment system and to improve the processing capability for both wastewater and oil. The waste is pumped to one of 4 batch treatment tanks and a tank is added to increase detention time. Insoluble oils separate by gravity in the batch treatment tanks and are skimmed to a new oil/water separation tank. Oil skimming is accomplished by pumping treated effluent to the lower portion of the batch tank. After skimming the free oil, pH is adjusted to 6-7 and chemicals are added using a new chemical transport system which provides for the addition of 5 chemicals (sulfuric acid, caustic, alum, emulsion breaker and polymer). The more effective chemical application and treatment system and the increase in treatment time have resulted in a batch treatment tank effluent that is suitable for direct discharge to the sanitary sewer. In 1981 a comparison of treatment plant total operation and maintenance costs and the return on oil reclaimed at the facility shows a net profit for the treatment plant.
W85-05245

WASTE TREATMENT IN AN AUTOMOTIVE COMPONENT COMPLEX,
Gilbert/Commonwealth, Inc., Jackson, MI.
S. P. Gambhir, and R. Johnston.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 203-206. 1 Tab.

Descriptors: *Wastewater management, *Metal-finishing wastes, Oil, Sludge, Cleanup.

A case history of wastewater management in a metal working plant is described. The manufacturing operations of the Saginaw Steering Gear Division of General Motors Corporation consists of cold heading, grinding, machining, metal coating, and heat treating. The manufacturing operations are located adjacent to Wheeler National Wildlife Management Area. Wastewater from the site originates from cleanup and blowdown that occurs due to various plant operations. These operations consist of several phosphating lines which discharge rinse water and other wastes; many parts washers; waste coolants that occur from filtration systems; dumping of contaminated filtration systems and wash water from miscellaneous cleanup operations. Wastewater from the manufacturing plant is conveyed by a gravity sewer to a deep sump. The wastewater is lifted to a distribution channel which feeds 2 API separators. In the treatment cycle, a measured amount of diluted emulsion breaker (a cationic polymer) is added to the waste to destabilize the oil-in-water emulsion. The split oil coagulates, flocculates and floats to the surface of the batch tank. The treated waste is discharged from the bottom of the batch tanks to the suction of 2 centrifugal pumps located in a pump house. The split oil sludge is pumped to a tank farm. The sludge and skim oil are hauled away by outside firms. The skimmed oil is shipped to an oil reclaimer where it is cleaned and necessary additives are added to meet various oil specifications. Since startup the plant has consistently met the limitations imposed by state and federal regulations.
W85-05246

NEW METHOD FOR OIL TANKER BALLAST WATER DEOILING,
Ecodyne Corp., Union, NJ. Graver Water Div.
R. T. O'Connell.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 207-212. 4 Fig, 2 Tab, 3 Ref.

Descriptors: *Oil tankers, *Oil wastes, *Ballast, Coalescence, Deoiling, Ion exchange, Oil skimmers.

The contamination of the oceans by oil is a problem of vast magnitude. Elf Aquitaine, a French petroleum company, has applied a new oil removal technique to the treatment of oil tanker ballast water. The technique used synthetic ion exchange resin as a coalescing medium. It is applied as a polishing unit for the effluent of API separators or storage tanks equipped with skimmers. Commercial installations exist at Brest Harbor, France where the Brest facility is for repairing oil tankers and Bayonne Harbor, France where the Bayonne facility is operated by a reginal port authority. The Elf coalescing process offers a unique method of polishing ballast water, and other oil wastewaters. One of the benefits realized is the elimination of chemical feeds (acid, alum, polymer, etc.), while still achieving low effluent oil concentrations. Once the oleophilic groups are affixed to the resin beads, they remain stable over a wide range of pH (2-12) and temperature (up to 250 F). The bond between the oleophilic group and the resin is also not affected by organic solvents sometimes used in tank cleaning.
W85-05247

MUNITIONS MANUFACTURING WASTEWATER TREATMENT: A GRASS-ROOTS FACILITY CASE HISTORY,
Engineering-Science, Inc., Atlanta, GA.
R. A. Mannebach, M. R. Hockenbury, and W. M. Reilly.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 213-222. 4 Fig, 5 Tab.

Descriptors: *Wastewater treatment, *Explosives, Zinc, Heavy metals, Influent streams.

A comprehensive conservative approach to a unique wastewater treatment problem is discussed. The design provides a technically feasible and flexible system capable of meeting the client's operational requirements and stringent effluent limits. The Industrial Wastewater Treatment facility design features include the following: efficient treatment facility design for 4 distinct production operating conditions (round-the-clock, one-shift-per-day, no production but with equipment maintenance, and total plant shutdown); capability to handle 8 different sources of wastewater, consisting of 4 continuous wastestreams and 4 batch wastestreams; zinc chloride precipitation for complexed ferrocyanide and ferricyanide treatment; carbon adsorption for ABS treatment a three-stage pH adjustment, precipitation and removal system for heavy metal treatment; a sulfide polishing system for residual heavy metal removal; filtration for residual heavy metal hydroxide removal; and a unique flow scheme which utilizes parallel pretreatment systems designed to treat selected contaminants in the 8 influent waste streams, followed by a combination treatment system designed primarily for heavy metal removal.
W85-05248

LAND TREATMENT OF WASTE AS AN INDUSTRIAL SITING ADVANTAGE,
Law Engineering Testing Co., Marietta, GA.
G. L. Taylor, and L. A. Neal.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 233-238. 2 Tab.

Descriptors: *Land use, *Industrial wastes, *Site selection, Hazardous materials, Electroplating, Crop production, Groundwater.

Industrial siting has been limited to sites within pumping distance of an adequate waste treatment facility, or a river capable of assimilating the waste ouput from an onsite system. Land treatment of industrial wastes uses a vegetation-soil system to both renovate the waste and to serve as the ultimate receiver of the waste. If land treatment is feasible at a site, the need for sewers is eliminated. There are 4 basic waste application techniques: rapid infiltration, overland flow, spray irrigation, and soil incorporation. The limitations of land treatment include the availability of the land. If the potential industrial site is land locked, and land is not available, conventional methods of treatment have to be utilized. Each land treatment site has to be analyzed as a unique set of conditions. A land treatment system cannot be designed for one site and that design transferred to another site. Many of the hazardous wastes are treated effectively by land treatment. Three categories of crops are usually grown on a land treatment system: agronomic or row crops, forage crops and grasses, and forested systems. Construction involves basically 3 components: storage basin, pumping to move the wastes, and distribution system. A case history is presented of an electroplating manufacturer and a nondischarge waste treatment system. The ambient ground water quality of the site is within current drinking water standards. The buffer zones around the site are planted to trees and shrubs to provide a multistoried canopy to prevent drift of spray droplets and to provide a visual barrier.
W85-05249

ASSESSMENT OF FLUID CONTROL LINER INSTALLATION PROCEDURES,
Southwest Research Inst., San Antonio, TX.
D. W. Schultz, and M. P. Miklas, Jr.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 239-251. 8 Tab, 5 Ref.

Descriptors: *Linings, *Clays, *Landfills, *Compaction, *Asphaltic concrete.

Field observations at 21 liner construction sites indicate installers generally comply to a large degree with industry recommendations regarding subgrade preparation and liner placement procedures. Clay liners are often utilized for fluid impoundments or landfills when a relatively higher fluid permeability can be tolerated. The most important parameters for the recompaction of offsite clay for use as a liner are: compaction energy and lift height. Asphaltic concrete used of liner should contain a higher percentage of mineral filler and asphalt than standard paving asphaltic concrete. For proper placement of asphaltic concrete liners, subgrades must be smooth and flat. Polymeric membrane liners are utilized to seal fluid impoundments and landfills. The liner must be secured at the top of any slope. Proper sealing around any penetrations must be accomplished. Both excessive precipitation and cool temperatures can adversely affect the quality of a given liner installation. Sprayed on liners are formed in the field by spraying a liquid onto a supporting surface. The types of sprayed on liners include: urethane modified asphalt, emulsified asphalt, latex rubber compounds and air blown asphalts. Soil sealants reduce the permeability of soil through a variety of mechanisms, including ion exchange and porosity reduction. The manufacturers of polymer modified bentonite soil sealants recommend dry blending with the soil for construction of a soil liner.
W85-05250

WATER AND WASTEWATER SURVEY FOR THE BRAZILIAN MERCK, SHARP AND DOHME CHEMICAL AND PHARMACEUTICAL PLANT,

Calgon Corp., Pittsburgh, PA.
J. G. Rabosky, and W. G. Schuliger.

In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 259-270. 3 Fig, 5 Tab.

Descriptors: Wastewater treatment, *Chemical wastewater, *Pharmaceutical wastewater, Water treatment, Sao Paulo, Brazil.

A water and wastewater survey conducted at Merck, Sharp and Dohme's industrial and pharmaceutical facility in Sousas, Brazil, near Campinas in the state of Sao Paulo is presented. The facility produces chemicals, agricultural veterinary products and pharmaceuticals. The plant's water supply is the Atibaia River. The intake pumps transfer canal water to the flocculation basin, where lime and alum are added for pH control and coagulation. Clarified water is chlorinated in a wet well and pumped to filters for additional removal of suspended solids. The plant's water balance shows that untreated intake flows range 160-370 gpm, with an average flow of about 255 gpm. Stormwater and industrial wastes are discharged into 2 open concrete ditches. Sanitary wastes are collected and discharge into the municipal sanitary sewer. The existing wastewater treatment plant consists of an 8000 gallon wooden neutralization tank where acid and lime and added on a batch basis. A proposed wastewater treatment process consists of equalization, neutralization, primary settling, sludge concentration and carbon adsorption. Variations in water demand should be controlled by installing start-stop controls on the pump; flow diversion valve on the pump discharge in order to direct the excess flow to the river; or manual bypass pipe and valve on the flocculator feed in order to divert the excess water to the river. Flocculation and sedimentation can be improved by maintaining pH as near to 7.0 as possible. Coagulation/flocculation of river water can be improved by using polyelectrolytes in combination with the present treatment scheme. The current neutralization practices of wastewater are inadequate.
W85-05251

DUAL NONSTEADY-STATE EVALUATION OF STATIC AERATORS TREATING PHARMACEUTICAL WASTE,

Manhattan Coll., Bronx, NY. Dept. of Environmental Engineering and Science.
J. A. Mueller, R. Donahue, and R. Sullivan.

In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 271-283. 7 Fig, 5 Tab, 6 Ref.

Descriptors: *Activated sludge process, *Aerators, *Pharmaceutical wastes, Sludge, Wastewater treatment, Aeration.

A bench scale activated sludge design study was conducted at the Merck and Co., Inc. Stonewall Plant in Elkton, Virginia, from January 10, 1980 through May 30, 1980. The purpose was to define the design criteria for a new activated sludge system to replace an existing activated sludge system and rock biofilters. The dual nonsteady state technique requires 2 consecutive nonsteady state aeration tests to be conducted at different gas flows in an aeration tank having a constant oxygen uptake rate. Clean water static aerator testing was conducted using the nonsteady state reaeration test procedure. The clean water data shows more scatter than expected at the higher gas flows and a relatively low correlation coefficient compared to the process values; however, reasonable agreement to the factory test data is observed. Temperature does not appear to markedly affect clean water values. The excellent agreement of the calculated and measured oxygen saturation values indicates the validity of the dual nonsteady state testing technique for K sub L a measurement in completely mixed aeration tanks under process conditions. The process water results show a tendency for alpha to vary with airflow. Future testing is planned to define the effects of wastewater on oxygen transfer of fine bubble aerators.
W85-05252

RECOVERY OF PROTEIN FROM SLAUGHTERHOUSE EFFLUENTS BY DOUBLE ADJUSTMENT OF PH,

Meat Industry Research Inst. of New Zealand, Hamilton.
R. N. Cooper, J. M. Russell, and J. L. Adam.

In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 285-293. 7 Fig, 5 Tab, 24 Ref.

Descriptors: *Meat processing industry, *Nitrogen compounds, *Blood, *Phosphorus removal, Biological oxygen demand, Chemical oxygen demand.

The effluent from a slaughterhouse characteristically contains high concentrations of fat and organic nitrogen. Primary treatment removes only 20 per cent of the organic nitrogen. Further treatment can be effected only by biological or chemical methods. The mechanisms of double pH adjustment are described. The procedure includes an evaluation of the initial and final pH values, the influence of neutralizing agent, and the influence of superphosphate. The results indicate that for a double pH adjustment process to be effective, the effluent must be initially acidified to pH 3 and that it is the blood component that dictates values between 4 and 6 the tetramer splits into 2 dimer units. This reaction is reversible on neutralization. Between pH 3 and 4 the reversibility of this reaction decreases, becoming irreversible at pH 3 and the dimer units split into monomer globin chains. Globin shows minimum solubility between pH 6.5 and 7.0. Below pH 7, both sodium hydroxide and calcium hydroxide had similar effects for neutralizing hemoglobin solutions; above pH 7, the rate of solubilization is greater with sodium hydroxide than with calcium hydroxide. A modification of the process, adding superphosphate in the acidification stage and then neutralizing to pH 9 with lime, slightly improves effluent quality, probably due to entrapment of colloidal material in the precipitated hydroxyapatite. In a model plant using the modified process, BOD, COD, organic nitrogen and inorganic P removals of 76, 81, 63, and 90%, respectively, were achieved.
W85-05253

ANAEROBIC FLUIDIZED BED WHEY TREATMENT,

State Univ. of New York at Buffalo. Dept. of Civil Engineering.
P. H. Boening, and V. F. Larsen.

In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 295-304. 7 Fig, 3 Tab, 17 Ref.

Descriptors: *Food processing industry, *Anaerobic digestion, *Fluidized bed process, *Chemical oxygen demand, Nutrient requirements, Microorganisms, Organic loading, Milk, Dairy industry, Whey, Waste treatment.

Anaerobic treatment of moderate strength lactic casein whey permeate (2000-7000 mg/l COD) is possible in fluidized bed reactors. Removal efficiencies up to 90 per cent were obtained at organic removal rates of 7.7 kg COD/cu m-day and efficiencies of 70 per cent were obtained at organic removal rates of 19.5 kg COD/cu m-day, both at 35 C. A removal rate of 310 kg COD/cu m-day at 50 per cent removal efficiency was obtained at 15 C. Nutrient requirements were much lower than for CSTR systems, no supplemental nitrogen or phosphorus was required for treatment. Removal efficiency decreased with increased organic loading rates, but removal rates per unit mass of microorganisms increased with increased organic loading rates. Microorganism concentration increased with decreased temperature compensation in part for the decrease in reaction rates at the lower temperture. Microorganism concentration was not limited by organic loading rate and may not have reached steady state levels. The most effective kinetic model was dependent on the influent substrate concentration.
W85-05254

FIVE-DAY BIOCHEMICAL OXYGEN DEMAND REMOVAL FROM RENDERING PLANT WASTEWATER,

Woodard and Curran, Gorham, ME.
K. R. Marston, and E. E. Woodard.

In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 305-310. 6 Fig, 4 Tab.

Descriptors: *Activated sludge process, *Dissolved air flotation, *Meat processing industry, Biochemical oxygen demand, Sludge, Wastewater treatment, Rendering plant.

A bench-scale pilot study showed that the dissolved air flotation (DAF) effluent from Pine State By-Products was amenable to treatment using the activated sludge process. A prototype activated sludge system was designed to provide the maximum amount of treatment with minimum of area and capital costs by utilizing a high MLSS concentration and F/M. The prototype system has performed very well under varying conditions. Waste activated sludge, along with sludge from the DAF system, is recycled to the plant for processing into high protein feed supplement. This eliminates the need for offsite sludge disposal. Based on an average influent BOD to DAF system of 65,000 mg/l, the treatment system (DAF followed by activated sludge) provides over 99 per cent BOD removal. The treatment system has been performing so well that a license has been granted for recommencement of overboard discharge of treated effluent, eliminating sewer use charges.
W85-05255

TREATABILITY OF DAIRY WASTEWATER,

Alexandria Univ. (Egypt). Higher Inst. of Public Health.
A. Hamza.

In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 311-319. 8 Fig, 4 Tab, 8 Ref.

Descriptors: *Wastewater treatment, *Dairy industry, *Activated sludge process, Effluents, Sludge, Biological oxygen demand, Organic carbon, Reverse osmosis, Milk, Cheese, Yogurt.

A field study is reported which sampled and characterized process effluents from Misr Dairy Company and proposed in-plant control measures and treatment alternatives are given. The plant produces pasteurized milk, yogurt and various kinds of cheese. Process effluents amount of 0.8 million cu m annually. The raw combined effluent from Misr Dairy plant was preaerated for 12 hours before feeding to the activated sludge unit at predetermined flowrates to obtain hydraulic detention times between 12 and 36 hours in the aeration tank. Advanced treatment of dairy waste, conducted at Hokkaido University in Japan consisted of treatment of dairy wastewater in reverse osmosis unit and multiple treatment using coagulation, adsorption and reverse osmosis. Preventive measures suggested for Misr Dairy Plant are: segregation of whey wastes and their possible use as an ingredient in animal feed; installation of drip shields on all fillers; use of automated valves with special seals to minimize leakage; better control of production to minimize losses in receiving, transfer and packaging areas; application of multiple reuse for cleaning compounds in the CIP system; and use of cooling water in closed cycle. The treatment efficiency of the activated sludge system decreased appreciably when influent BOD increased beyond 2000 mg/l. Extended aeration for 30 to 36 hours was necessary to attain adequate removals of the organic pollutants. The need for coagulation-adsorption pretreatment before feeding the effluent to the reverse osmosis system was demonstrated. Multiple treatment by coagulation, adsorption and reverse osmosis achieved reduction of TOC up to 97.5%.
W85-05256

FERMENTATION PROCESS FOR DILUTE FOOD AND DAIRY WASTES,

Abcor, Inc., Wilmington, MA.
V. Singh, C. C. Hsu, D. C. Chen, and C. H. Tzeng.

In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 321-327. 6 Fig, 3 Tab.

Descriptors: *Wastewater treatment, *Dairy industry, Effluents, Biological oxygen demand, Fermentation, Alcohols, Reverse osmosis, Food-processing wastes, Grain milling, Potatos, Sugar beets, Whey, Milk.

Many food and dairy operations produce large quantities of high strength waste effluents that constitute a major disposal problem. Many of these streams are dilute (4-5 per cent total solids), yet have a BOD in the range of 20,000-50,000 mg/l. The high BOD levels are chiefly due to sugars and starchy material in the wastewater. Many of the waste effluents are well defined, sanitary, contain fermentable carbohydrates and nutrients, and are available year round at fairly constant rates. One of the products that can be made from waste carbohydrates is ethanol by fermentation. The Abcor process converts lactose to ethyl alcohol. The dilute permeate from ultrafiltration operation is concentrated by reverse osmosis 3.5 times and then fed to the fermentation unit. During fermentation, the lactose in the permeate is converted to ethanol; some of the lactose is also converted to carbon dioxide and yeast cells. The dilute alcohol broth (9 per cent by volume) is fed to a distillation unit where the alcohol is concentrated. Final product concentration depends on the application: from 95 per cent ethanol to 99.5 per cent purity. The Abcor fermentation process is a continuous operation; concentrated permeate is constantly fed to the fermentors and product constantly withdrawn. The process, although developed specifically for the fermentation of cheese whey permeates, can be used for treating a variety of dilute food and dairy wastes, such as grain milling water, potato and sugar beet process effluents, and milk, acid whey and delactosed whey ultrafiltrates.
W85-05257

SLUDGE RECYCLING FOR METHANE FERMENTATION PROCESSING OF SWINE WASTEWATER,
Hawaii Univ. at Manoa, Honolulu. Dept. of Agricultural Engineering.
P. Y. Yang, and Y. T. Wong.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 329-337. 13 Fig, 4 Tab, 15 Ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Methane bacteria, Fermentation, Sludge, Meat processing industry, Anaerobic digestion, Hogs.

Anaerobic fermentation of swine wastewater with recycling digested sludge provides an improved and stable process. The maximum gas yield and gas production rates are 1.05 liter of gas produced (67.5 per cent methane gas) and 2.72 liter of gas produced per liter of reactor liquid volume per day, respectively. The rate equations for estimation of TVS content in the effluent and gas production rate have been developed and tested for its predictability. Improvement of settling of anaerobically digested sludge can be achieved by using 50 C of instant heat treatment. Such heat treated settled sludge can be used for sludge recycling in an anaerobic fermentation process. The recommended design and operational critera for anaerobic fermentation of swine wastewater are summarized as follows: temperature, 30 C; ratio of flowrate of recycled sludge to influent flowrate, 0.25-0.30; critical swine wastewater hydraulic retention time, 6.5 days when alpha equals 0.25, c equals 2.0; feeding frequency, 3 times a week; TVS loading rate, below 4.0 gram per liter of liquid volume per day; degasification temperature of digested sludge, 50 C; and settling time for heated sludge recycling, 5 hours.
W85-05258

WASTEWATER TREATMENT AT A SWEDISH CARDBOARD FACTORY: POSSIBLE COST SAVINGS,
Svenska Traeforskningsinstitutet, Stockholm.
G. Fladda, E. Kubulnicks, B. Boman, J. Norman, and L. Ruus.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 339-352. 11 Fig, 3 Tab, 3 Ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Pulp and paper industry, *Cost analysis, Sludge, Automation, Cardboard.

The wastewater treatment system at a Swedish cardboard factory (production, 400 ton/day) was investigated to study the behavior of the treatment system and evaluate possible cost savings. The wastewater treatment plant consists of primary sedimentation, trickling filter, 2 activated sludge units in series, chemical treatment, clarification and microstrainers. For sludge treatment there are 2 thickeners and a belt press for sludge dewatering. Cost savings could be achieved in the following way: reduction of fiber losses from the cardboard factory; automatic control of the oxygen concentration in the aeration basins; automatic control of the addition of chemicals for flocculation; reduced addition of nutrients (N and P); and improved regulation of the pumps at the wastewater treatment plant. The most important cost saving was a reduction of the fiber losses from the factory, and this could be achieved by installation of an automatic control system. Significant energy savings were also obtained by such simple measures as a better regulation of the pumps in the main sump at the treatment plant. According to the calculations made the possible annual energy savings amounted to 5800 MW-hr and the annual cost savings to $981,900. Considerable cost savings can be obtained at unchanged or even improved treatment efficiency.
W85-05259

TREATMENT SYSTEM FOR CONTROL OF RADIOACTIVE WASTEWATER GENERATED DURING CLEANUP OF THE CANONSBURG, PENNSYLVANIA, SITE OF THE URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM,
Weston (Roy F.), Inc., West Chester, PA.
J. W. Hammond, and A. L. Lenthe.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 387-396. 2 Fig, 3 Tab.

Descriptors: *Wastewater treatment, *Uranium, *Radioactive waste disposal, Radioactivity, Groundwater, Sedimentation, Filters, Suspended solids, Radon, Radium, Thorium.

The Canonsburg site (Canon Industrial Park) is located in southwestern Pennsylvania, in northern Washington County. Radiological surveys determined that significant amounts of contaminated material remain on the site and the radiation levels measured in the buildings, soils and groundwater exceeded the proposed DOE guidelines for remedial action. Radium-bearing residues are present in soil beneath and adjacent to many of the buildings, as well as in the top few feet of soil over much of the area. Radon, radon-daughter products, and 230Th levels in building air are also above guidelines. The groundwater in area A is above the maximum permissible concentrations. Area B is above guidelines for radioactivity, although with lower contamination levels than Area A. Area C, a former lagoon area, was used as a depository for liquid wastes during uranium and radium recovery operations. The remedial action scenario is modular in approach, allowing various parts of the plan to be deleted if possible, based on the results of additional field studies. During the implementation of the decontamination program wastewaters will be generated that must be treated to remove radioactive species prior to discharge to Chartiers Creek. The wastewater treatment strategy includes a sedimentation basin for collecting runoff and other wastewaters generated at a rate in excess of the capacity of the treatment facility, followed by multimedia pressure filters to control suspended material, and followed by cation/anion exchange beds to control dissolved species. The design capacity of the treatment faciltiy is 100 gpm; the estimated construction cost is $760,000.
W85-05262

CONTROLLING RESIDUAL POLYCHLORINATED BIPHENYLS IN WASTEWATER TREATMENT THROUGH CONVENTIONAL MEANS,
Aluminum Co. of America, Lafayette, IN.
L. L. Fox, and N. J. Merrick.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 413-423. 2 Fig, 7 Tab, 12 Ref.

Descriptors: *Physicochemical treatment, *Emulsions, *Wastewater treatment, *Polychlorinated biphenyls, Clarifiers, Sludge, Filters, Esters, Phosphates.

Polychlorinated biphenyls (PCB) were used at the Aluminum Company of America (Alcoa) Lafayette Works primarily in fire-resistant hydraulic fluids called phosphate esters. Through leaks in hydraulic systems and careless handling practices, PCB's found their way into the trenches and industrial sewer systems on the plant site. The treatment plant consists of a physical-chemical clarifier combined with a conventional primary clarifier, trickling filter and final clarifier. The industrial waste stream consists largely of an oil-in-water emulsion. From the industrial wet well, the waste stream is pumped into a holding tank, then through a venturi which operates a lime feeder and polymer pump, and then the waste enters the industrial reactor clarifier. A valve is used to blowdown clarifier sludge into a common sludge pit, which also receives anaerobic digester sludge. The clarifier also is equipped with a skimming device that returns skimmed material to the industrial wet well. Lime and at times a polyelectrolyte are added as a conditioning agent to the industrial and digested sludge in the sludge pit. The sludge is dewatered over a coil spring vacuum filter. The dewatered solids are hauled to a chemically secure landfill. The majority of the 93.6 per cent PCB reduction during the 12-week special sampling program was achieved by physical-chemical removal in the industrial clarifier. All efforts are being directed toward optimizing the waste treatment operation through managing of the industrial influent flows and eliminating treatment plant upsets. This is accomplished by constant monitoring of the plant processes.
W85-05263

EVALUATION OF ION EXCHANGE TECHNOLOGY FOR TOXIC AND NONCONVENTIONAL POLLUTANT REDUCTION IN BLEACH PLANT,
Jordan (Edward C.) Co., Inc., Portland, ME.
J. H. Fitch, Jr.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 425-433. 3 Fig, 7 Tab.

Descriptors: *Ion exchange, *Color removal, *Pulp and paper industry, *Wastewater, Effluents, Bleaching wastes, Chemical oxygen demand, Phenols, Chlorinated hydrocarbons, Metals, Waste treatment.

The wastes resulting from bleach plant operation in the pulp, paper and paperboard industry characteristically contribute color, chemical oxygen demand (COD) and toxicity to the effluent wastestreams discharged. Three ion exchange design schemes have been developed for treating bleach plant effluents: the Dow process, the Rohm and Haas process, and the Billerud nonpolluting bleach plant concept. The Billerud system is a patented ion exchange technology instituted at the Billerud Uddeholm AB mill in Skoghall, Sweden. A full-scale batch ion exchange system was installed to allow the plant to meet its color limitation. In addition to reducing color discharges by approximately 90 per cent, the system removed other pollutants including chlorinated phenols (95-99 per cent), chlorinated guaiacols (80-90 per cent), and COD (70 per cent). Both the batch and pilot plant systems were sampled to assess actual operating parameters, removal efficienies, and associated problems and costs. The first ion exchange column appears to remove a constant portion of the load after approximately half the sample time while the removal efficiency of the second column consistently decreases throughout the cycle. Any metal

removal probably resulted from the metals binding with sulfhydryl groups, amide chelation, or electrostatic attraction to negatively charged macromolecules. Though some inorganic chloride is removed initially, the removal rate rapidly decreases to a low level; most chlorides pass through the system. Excessive amounts of pollutants passed through the system when the contact time on the resin columns was extended.
W85-05264

PRIORITY POLLUTANT REMOVAL BY ACTIVATED SLUDGE TREATMENT: MONITORING PHENOLS FROM DYE AND PIGMENT WASTE,
Cincinnati Univ., OH. Dept. of Civil and Environmental Engineering.
J. Rickabaugh, and M. Lambert.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 435-443. 5 Fig, 6 Tab, 6 Ref.

Descriptors: *Ion exchange, *Color removal, *Activated sludge, *Pigments, *Phenols, Dyes, Dye industry wastes, Chlorinated hydrocarbons, Metals.

The monitoring of the removal of pollutants from industrial waste streams is studied, and an analytical service for an activated carbon-activated sludge system used to treat a dye and pigment waste is provided. The experimental analysis plan for specific organics was to identify by GC/MS compounds of significantly high level of concentration to monitor by flame ionization detection/gas chromatography analysis through the biological treatment process from influent to secondary effluent. Routine monitoring for trace constituents presents some special problems. Available methodology cannot be expected to perform equally well for all kinds of samples. The limitations of methods must be clearly identified whenever possible, in order to evaluate the usefulness of the data produced. Even though low recoveries and high variability were found, the data are still valuable in that treatment trends can still be seen. This study points out the need for further method development in the analyses of individual phenols in complex matrices.
W85-05265

AUXILIARY DEMINERALIZATION SYSTEM FOR LIQUID RADIOACTIVE WASTE,
Chin Shan Nuclear Power Station (Taiwan).
M. H. Lin, and C. R. Witt.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 445-449. 4 Fig, 1 Tab.

Descriptors: *Radioactive wastes, *Demineralization, *Nuclear powerplants, Ion exchange, Suspended solids, Waste treatment.

Concern over the effluents from nuclear power plants has led to increased efforts to achieve zero release to the environment. A major source of release from a plant is through its liquid radwaste system. A system was recently installed to augment the liquid radwaste system. This has dramatically reduced its radioactive activity releases to the environment via the liquid effluent pathway. This system that Chin Shan installed is called the auxiliary demineralization system (ADS). The equipment drain processing system collects, samples and treats high purity, low conductivity waste. The waste collector filter receives effluent from either the waste collector or the waste surge pump. It removes suspended solids and passes the effluents to the waste demineralizer. The waste demineralizer is a mixed-bed ion-exchange type, that further removes impurities from the waste stream. Liquid radwaste is pumped from either the waste collector tank or the waste surge tank using the ADS pump through the ADS to either waste sample tank. In an alternate mode, liquid radwaste is pumped from either the waste collector tank using the waste collector pump or the waste surge tank using the waste surge pump, through the waste collector filter, and even through the ADS to either waste sample tank. With the waste sample tank recirculate mode, liquid radwaste is pumped from either waste sample tank using that tank's waste sample pump, through the ADS, and returned either to the same waste sample tank or to the opposite one. With the recirculate mode, liquid radwaste is internally recirculated through the ADS using the ADS pump.
W85-05266

CARBON TREATMENT OF PESTICIDE WASTEWATERS IN LIGHT OF BEST AVAILABLE TECHNOLOGY EFFLUENT LIMITATION GUIDELINES,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
K. N. Wood, O. R. Hunt, and J. J. Anderson.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 451-463. 9 Fig, 6 Tab, 32 Ref.

Descriptors: *Wastewater treatment, *Pesticides, *Agricultural chemicals, *Activated carbon, Cost analysis, Load distribution, Hydrogen ion concentration, Effluents.

A two phase program was undertaken with static isotherm tests with synthetic solutions of active ingredients in distilled water, followed by dynamic column studies with actual manufacturing process waste streams to: ascertain the efficacy of activated carbon in removing Du Pont agrichemical compounds to low levels in the aqueous phase and evaluate the cost-effectiveness of carbon treatment relative to alternate pesticide removal methods. The static isotherm test results demonstrated that activated carbon can reduce the concentration of Du Pont agrichemical compounds to low levels, but that adsorption characteristics are variable between compounds. Batch test results with synthetic solutions give overly optimistic predictions of adsorption capacities using the Freundlich isotherm equation. Dynamic column studies with actual process waste samples are required to accurately predict the effectiveness of activated carbon and to develop information for comparison with other treatment methods. Surface loading rate or linear velocity, pH and pesticide concentration were the variables identified as being significant factors in determining carbon adsorption. The presence of other pesticides in a multicomponent waste did not affect the behavior of one pesticide in the dynamic testing mode when compared to results obtained with it as the only pesticide in the waste. The adsorptivity of other organic contaminants in the manufacturing waste streams could be characterized as poor in relation to that of the active ingredient (i.e., the pesticide is preferentially adsorbed.) Cost-effectiveness was clear for only 2 of the 8 products.
W85-05267

STEAM STRIPPING OF COAL LIQUEFACTION WASTE FOR AMMONIA AND SULFIDE REMOVAL,
Louisville Univ., KY. Dept. of Chemical and Environmental Engineering.
K.-C. Tsai, M. A. Kamer, and J. H. Gray.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 465-473. 3 Fig, 3 Tab, 7 Ref.

Descriptors: *Mine wastes, *Coal, *Liquid wastes, *Ammonia, *Sulfides, Hydrogen ion concentration, Activated sludge process, Steam stripping.

Ammonia-nitrogen and sulfide are the two most important pollutants contained in coal liquefaction waste. If not removed, these two pollutants will present a great deal of nuisance to the environment. The feasibility of removing both ammonia-nitrogen and sulfide from coal liquefaction sour water in a laboratory stripping column at one single pH was examined. The steam stripping experiment was conducted by using a distillation apparatus commonly used in solvent recovery operations. A total of 14 steam stripping experiments were run at various pH to determine whether or not both ammonia-nitrogen and sulfide can be reduced to desired low levels at one single initial pH in one stripping column. The analytical results for the sour water reveal that both ammonia-nitrogen and total sulfide extraordinarily high with 9200 mg/l NH3-N and 9500 mg/l total sulfide. These high levels of ammonia-nitrogen are toxic to activated sludge microorganisms. At an initial pH of 9.25 both ammonia-nitrogen and sulfide could be reduced to very low levels. At a high temperature of 95 C in the stripping column, effective stripping of sulfide can be accomplished even at an alkaline pH of 9.75. Total elimination of sulfide was observed at a pH of 9.20. Recovery of ammonia-nitrogen from distillate for reuse is very promising because of the high NH3-N concentration obtained. The average NH3-N concentration in the first 50 ml distillate collected was 152,000 mg/l.
W85-05268

OPERATING EXPERIENCE WITH AN INTEGRATED POWER PLANT WASTEWATER TREATMENT SYSTEM,
Sargent and Lundy, Chicago, IL.
R. Chiesa, and P. D. Schumacher.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 475-487. 9 Fig, 6 Tab, 11 Ref.

Descriptors: *Wastewater treatment, *Powerplants, Coal, Chemical wastes, Oil, Iron, Copper, Grease.

The design and operation of an integrated wastewater treatment system (WWTS) used to treat the chemical wastes from a coal fired power plant are described. An integrated WWTS treating metal cleaning wastes, low volume wastes, and material storage runoff from WEPCo's new coal fired power plant has successfully been meeting its NPDES effluent limitations for almost two years with no major operational problems. The WWTS has demonstrated the flexibility to treat a variety of chemical wastes generated by the power plant (metal cleaning wastes such as oil, grease, iron, and copper). No major problems are expected in the operation of the WWTS when Unit 2 comes on line. Minor problems have occurred, but these have been corrected. The operators have increased their proficiency in operating the WWTS. The success of the integrated WWTS at the Pleasant Prairie Power Plant has demonstrated that the concept of an integrated WWTS can be used to design a cost effective WWTS which complies with the EPA effluent limits. Feedback from this project and from other operating WWTS has resulted in the incorporation of refinements in more recent designs of integrated WWTS.
W85-05269

TREATABILITY OF A COAL GASIFICATION WASTEWATER USING THE POWDERED ACTIVATED CARBON/ACTIVATED SLUDGE PROCESS,
O'Brien and Gere Engineers, Inc., White Plains, NY.
J. Janeczek, Jr., and J. C. Lamb, III.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 497-505. 9 Fig, 4 Tab, 19 Ref.

Descriptors: *Wastewater treatment, *Coal gasification, *Activated carbon, *Activated sludge process, Organic carbon, Chemical oxygen demand, Phenols.

To evaluate the effects of using powdered activated carbon and activated sludge (PAC/AS) in treating a coal gasification wastewater, six 2.3-liter bench-scale reactors were operated in parallel. Five of them received carbon dosages ranging between 250 and 5000 mg/l and the sixth, which served as a control, received no carbon. The reactors were operated for 142 days and reasonable stable operation was attained about day 110. Only results of analyses performed during the last 32 days of operation are presented. Results from all analyses were encouraging for using the powdered activated carbon-activated sludge process to treat coal gasification wastewaters. The addition of PAC to the activated sludge process increased color removal. The PAC/AS process exhibited better removals of total organic carbon (TOC), chemical oxygen demand (COD), and phenol, than did activated sludge treatment alone. The addition

of PAC to activated sludge increased the amount of biomass in the reactors, as determined by respiration rate analyses. The additon of PAC to activated sludge increased the amount of live biomass in the reactors, as determined by the ATP analyses.
W85-05270

BENZOL PLANT WASTEWATER TREATMENT IN A PACKED-BED REACTOR,
Duncan, Lagnese and Associates, Inc., Pittsburgh, PA.
M. Olthof, and J. Oleszkiewicz.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 519-525. 9 Fig, 18 Ref.

Descriptors: *Wastewater treatment, *Organic wastes, Packed beds, Chemical oxygen demand, Organic carbon, Benzol, Phenols.

The results of a treatability study of wastewaters originating from a benzol plant in an upflow biotower (UBT) are presented. The wastewater constituents are the same as for coke oven wastewater, except that most of the constituents are present in somewhat lower concentrations. The results show that the organics present in this wastewater are very well biodegradable and that it is possible to treat this wastewater biologically to a very high extent. The UBT proved to be an efficient reactor for biological degradation of benzol wastewater. Organic loadings as high as 300 lb COD/1000 cu ft-day resulted in 70 per cent or higher chemical oxygen demand (COD) removal. The percentage removal of CN and SCN was about 60-70 per cent at the loading at which the reactor was operated. Phenol is virtually completely oxidized as long as the percentage COD or SOC removal was above 50%. This does not necessarily mean that the phenol is completely oxidized but at least the ring is broken and the resulting organic does not register as phenol.
W85-05271

TREATMENT OF COKE PLANT WASTEWATER IN THE COUPLED PREDENITRIFICATION-NITRIFICATION FLUIDIZED BED PROCESS,
Canviro Consultants Ltd., Kitchener (Ontario).
S. G. Nutt, H. Melcer, I. J. Marvan, and P. M. Sutton.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 527-536. 4 Fig, 7 Tab, 10 Fig.

Descriptors: *Wastewater treatment, *Coke plant, Nitrification, Denitrification, Fluidized bed process, Hydrogen ion concentration, Retention time, Cost analysis, Organic wastes.

Liquid effluents generated from by-product coking operations are complex, containing high concentrations of phenolic compounds, thiocyanate, free and complex cyanide, ammonia, and a variety of trace organic contaminants that have been shown to produce adverse long term environmental impacts. Bench scale biological treatability studies conducted at Environment Canada's Wastewater Technology Centre (WTC) in Burlington, Ontario, have demonstrated that coke oven wastewaters can be nitrified and denitrified in single sludge suspended growth systems operated in a predenitrification mode. The fluidized bed process is a modification of more conventional fixed film processes, such as the trickling filter, in which wastewater is passed upward through a bed of granular support medium, typically sand, at a sufficient velocity to expand or fluidize the media. The pilot plant feed consisted of effluent from fixed and free leg ammonia stills at the by product coke plant of Dofasco Inc. in Hamilton, Ontario. Lime was utilized for pH adjustment in the fixed leg of the still. The results indicate that, under constant feed conditions, the coupled fluidized bed process was capable of maintaining a consistently high quality effluent at a total system hydraulic retention time (HRT) of approximately 17 hr. Effluent NH3-N concentrations of less than 2 mg/l were attained at a nitrification reactor HRT of 14 hours compared to a retention time of up to 48 hr required in a suspended growth nitrification reactor treating similar wastewaters. Removal of conventional carbonaceous contaminants (FOC) was consistently high. The estimated installed cost is $2,357,000; operating costs are estimated at $150,900.
W85-05272

OXIDATION OF ORGANIC COMPOUNDS IN SOLVENT-REFINED COAL II WASTEWATER VIA ULTRAVIOLET IRRADIATION,
Brown and Caldwell, Emeryville, CA.
J. C. Hein, K. E. Hartz, P. Bulson, and D. L. Johnstone.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 537-550. 15 Fig, 6 Tab, 12 Ref.

Descriptors: *Organic wastes, *Ultraviolet radiation, *Carcinogens, *Toxins, *Wastewater treatment, *Coal gasification, Liquefaction, Chemical oxygen demand, Organic carbon, Solvent refining, Coal.

Wastewaters containing a wide range of organic compounds are treated through biological decomposition. However, coal conversion wastewaters (gasification, liquefaction, synfuels) contain relatively large concentrations of certain groups of organic compounds that are not amenable to biological decomposition. Chemically they are aromatic amines, oxygen and sulfur heterocyclics, and polycyclic aromatic hydrocarbons. These compounds are of intense environmental concern because of their ability as bioaccumulators, as well as being toxins and carcinogens. To effectively remove these refractory compounds, their chemical structures must be altered to a more biodegradable structure. Observation and gas chromatographic analyses indicated that the UV treatment significantly changed the chemical character of the wastewater. The standard analytical methods for total organic carbon (TOC) and chemical oxygen demand (COD) indicated only minor differences. It appears the TOC instrument used in this research and the standard COD method have serious limitations when evaluating wastewaters containing relatively large concentrations of refractory compounds. Gas chromatographic analyses indicated that the photochemical reaction produced by the UV reactor preferentiallly attacked the base neutral compounds in the wastewater. The activated sludge in the UV bio unit exhibited a more uniform floc with better settling characteristics. Suspended solids in the bio unit effluents were reduced from 160 mg/l (mean) in the control effluent to 40 mg/l (mean) in the UV effluent. There was a decrease in the toxicity of the wastewater.
W85-05273

TOXICITY OF WET LIMESTONE SCRUBBER SLUDGES, ASH POND SLUDGES AND EFFLUENT WASTES FROM A COMBUSTION PROCESS,
Tennessee Technological Univ., Cookeville.
E. L. Morgan, T. C. Yehl, and R. C. Young.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 551-557. 7 Tab, 11 Ref.

Descriptors: *Coal combustion wastes, *Toxicity, Sludges, Fish, Sedimentation, Metals, Biological oxygen demand, Aquatic insects, Fly ash.

Treatment of coal combustion wastes by primary settling of solids effectively displaced the hazard of this complex waste discharge from the pelagic biota to the benthic biota. The highly regarded single species bioassay test may have provided an inaccurate assessment in this case study. Site specific single species toxicity tests were executed with water fleas and fathead minnows. Laboratory multispecies tests combining the burrowing mayfly, isopod, and water flea were performed to assess the potential toxicity of solid and liquid wastes. Physical and chemical data were collected onsite while the limestone scrubber system was in operation. The coal combustion waste has low BOD values. The effluent had increased levels compared to river water of cadmium, copper, arsenic and selenium during metal uptake tests with fathead minnow. Uptake and clearance of metals by fathead minnows indicated that most metals did not accumulate in fish tissue after 30 days of exposure to levels significantly higher than background values in effluent or river water. Zinc concentrated in tissues by a factor of about 8 in effluent, and did not undergo clearance of accumulated zinc when subsequently exposed to river water for up to 50 days. Site specific 28 day water flea reproductive tests in effluent dilutions revealed that effluent concentrations alter the day of first brood and reduce the number of broods per female. Information concerning mortality and emergence of burrowing mayfly nymphs and botton dwelling isopods following a 6 day laboratory exposure implied increased mortality.
W85-05274

BIODEGRADATION OF SULFOLANE IN REFINERY WASTEWATER,
Shell Development Co., Houston, TX.
C. C. Chou, and R. A. Swatloski.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 559-566. 4 Fig, 7 Tab, 2 Ref.

Descriptors: *Oil refineries, *Activated sludge process, *Sulfur compounds, *Industrial wastes, Biodegration, Chemical industry, Hydrogen ion concentration, Sludge, Sulfolane.

Sulfolane (thiocyclopentane-1,1-dioxide) is an important process chemical for the petroleum and chemical industries. The biodegradability of sulfolane in 2 bench scale suspended growth systems was assessed. The bench CMAS system was employed to simulate wastewater treatment operations. The pH was maintained at 7.0 plus or minus 0.2 with pH controller, and sodium hydroxide was used to neutralize the acid generated from sulfolane oxidation. Sulfolane did not affect the OUR of the nonacclimated activated sludge; it did enhance the uptake rate after a short term acclimation. The OUR doubled in the presence of only 1-2 mg/l sulfolane; however, the rate was not higher with 2-40 mg/l. During some batch degradation and oxygen uptake tests, it was observed that there was a significant decrease of pH accompanying sulfolane disappearance. Since the acclimated culture showed a substantial increase in OUR with n-butanol or butyric acid, it is conceivable that sulfolane may be converted to a 4-carbon intermediate and sulfate (or sulfite) after initial ring cleavage. The sludge volume index (SVI) ranged from 70 to 117 ml/g TSS. The interfacial settling velocity (ISV) increased from an initial 9.0 ft/hr without sulfolane, to 16-20 ft/hr after sulfolane addition. For nonacclimated activated sludge sulfolane shock loading had no effect on its settleability. The addition of sulfolane (up to 80 mg/l) to refinery wastewater does not affect the general performance of the treatment processes studied.
W85-05275

IMPROVING EFFLUENT QUALITY OF PETROCHEMICAL WASTEWATERS WITH MUTANT BACTERIAL CULTURES,
Sybron Corp., Birmingham, NJ.
J. A. Christiansen, and P. W. Spraker.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 567-576. 11 Fig, 6 Tab, 9 Ref.

Descriptors: *Wastewater treatment, *Industrial wastes, *Oil refineries, Effluents, Sludge, Biological treatment, Activated sludge process, Nitrification, Organic carbon.

The petroleum industry has made significant expenditures in equipment, chemicals and operating expertise to produce high quality effluents. Bichem mutant bacteria are developed through simple in situ genetic engineering. Nitrification is often required due to stream standards. Toxicity to nitrifiers occurred under several circumstances. Case studies of 4 refineries are presented. One refinery experienced periodic problems with its sour water stripper. Bichem 1008SF was added to the aeration lagoon. At the same time, Bichem 1010N culture, containing organisms that oxidize ammonia to nitrite and nitrate, was added to the activated sludge

system. Another refinery system used a 2 stage activated sludge system. Problems arose when a loss of MLSS occurred in the second stage at the same time as high oil and grease rendered first stage mixed liquor ineffective in reducing TOC. A reseeding of Bichem 1003FG, in combination with Bichem 1004TX, combined with complete elimination of sludge wasting during the recovery process resulted in a decrease in MLSS oil. A refinery located in the East, experiencing problems because of the cold, seeded the activated sludge system with Bichem 1004TX and 1008SF to dissipate the white frothy foam. Another refinery in the East, with problems because of the cold, added Sybron mutant bacterial cultures for 14 days and showed a marked decreased in effluent suspended solids and an increase in the number of stalked ciliates. A Houston area refinery has an activated sludge treatment process with 10-hr detention time. Complete nitrification was achieved in the fifth week of the trial, after a bioaugmentation program was begun.
W85-05276

COMPARISON OF ACTIVATED SLUDGE RESPONSE TO QUANTITATIVE, HYDRAULIC AND COMBINED SHOCK FOR THE SAME INCREASES IN MASS LOADING,
Delaware Univ., Newark. Dept. of Civil Engineering.
T. S. Manickan, and A. F. Gaudy, Jr.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 601-618. 11 Fig, 4 Tab, 30 Ref.

Descriptors: *Physicochemical treatment, *Activated sludge, Shock loads, Effluents, Chemical oxygen demand, Clarifiers, Suspended solids, Kinetics.

Shock loads of different types, hydraulic, quantitative, or combinations thereof, did not produce equivalent disruptions of effluent quality for equal increases in mass organic loading rate. Based on effluent concentrations, a purely hydraulic and a hydraulic-quantitative shock at the same mass loading resulted in equal increases in total effluent COD, but the increase was due primarily to suspended solids in the hydraulic shock and to soluble COD in the combined shock. Predictive kinetic equations based on mass balance for the reactor do not adequately predict the disruption in either solids concentration or soluble substrate. The clarifier can function as a bioreactor when it receives metabolizable soluble substrate during a transient which disrupts substrate removal in the aerator. It may not be possible to develop kinetic equations which incorporate all the variables that affect the response of a heterogeneous biomass to a severe shock load. The most logical approach to improvement of the present equations may lie in attempts to predict the direction and magnitude of changes in the biological constants brought about by various types of shock loads.
W85-05278

PREDICTIVE MODEL FOR TREATMENT OF PHENOLIC WASTES BY ACTIVATED SLUDGE,
Delaware Univ., Newark. Dept. of Civil Engineering.
A. Rozich, A. F. Gaudy, Jr., and P. D'Adamo.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 619-639. 8 Fig, 9 Tab, 25 Ref.

Descriptors: *Industrial wastes, *Phenols, Activated sludge, Kinetic model, Biomass, Chemical oxygen demand, Waste treatment.

A kinetic model for activated sludge treating inhibitory wastes has been devised and tested experimentally using phenol as inhibitory carbon source. The model employs the Haldane equation as the functional relationship between specific growth rate, mu, and exogenous substrate concentration, S, and utilizes control of recycle sludge concentration, XR, as a major selectable engineering control parameter of net specific growth rate. Predictions of process performance were made utilizing the model equations and the 5 biokinetic constants determined from the pilot plant data and from separate batch growth experiments. The model adequately predicted reactor biomass concentration, waste sludge production and effluent COD concentrations. However, the model predicted specific phenol concentrations in the reactor effluent significantly higher than the observed experimental values. Since several researchers have stated that predictive equations for the treatment of phenol can be based on the hyperbolic, Monod function for noninhibitory wastes, prediction of S, Se and Xw were made using model equations employing the Monod equation as well as those incorporating the Haldane equation. For the range of net growth rates, the two types of equations predicted essentially the same results. The use of a Monod function in the mass balance equations gives both the design engineer and the operator distorted view of the true operating range of the system and does not alter one to the existence of a critical operating point for an activated sludge process treating inhibitory carbon sources.
W85-05279

PREDICTING TREATABILITY OF MULTIPLE ORGANIC PRIORITY POLLUTANT WASTEWATERS FROM SINGLE-POLLUTANT TREATABILITY STUDIES,
Oklahoma State Univ., Stillwater. School of Civil Engineering.
D. F. Kincannon, A. Weinert, R. Padorr, and E. L. Stover.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 641-650. 6 Tab, 11 Ref.

Descriptors: *Organic wastes, *Prediction, *Kinetics, Biodegradation, Phenols, Nitrogen compounds, Halogenated hydrocarbons, Hydrocarbons, Waste treatment.

The possibility of predicting biokinetic constants for system containing several priority pollutants by using data obtained from systems containing a single priority pollutant is examined. Averaging of biokinetic constants was not satisfactory. A weighted average based on the relative concentrations of priority pollutants was not satisfactory in predicting the biokinetic constants in the combined systems. It appears that the biokinetic constants are the result of many factors and a better understanding of these factors must be developed before adequate prediction of biokinetic constants can be made. It can be predicted that nitrogen compounds, phenols, oxygenated compounds, polynuclear aromatics and phthalates will be removed by biological degradation. Aromatics will be removed by both biological degradation and stripping. Halogenated hydrocarbons present a special problem. Some are removed by stripping; others are removed by combined biodegradation and stripping. Biodegradability and stripping constants could be developed for each priority pollutant and used very successfully in predicting the effluent concentrations for the pollutants when combined with other priority pollutants or when the influent concentrations varied. It is possible to develop structure/activity correlations for predicting the fate of priority pollutants.
W85-05280

APPLICATION OF ANAEROBIC PACKED-BED REACTORS TO INDUSTRIAL WASTEWATER TREATMENT,
Newcastle upon Tyne Univ. (England).
G. K. Anderson, T. Donnelly, and K. J. McKeown.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 651-660. 2 Fig, 6 Tab, 9 Ref.

Descriptors: *Wastewater treatment, *Organic wastes, *Industrial wastewater, Anaerobic digestion, Methane, Packed beds, Food processing wastes, Ethanol, Molasses, Edible oils.

The treatment of organic wastewaters by anaerobic packed bed reactors offers advantages over other types of anaerobic treatment systems. The production of methane from wastewater is an obvious attraction since it can be shown that for every kg COD utilized about 0.35 cu m methane could be produced. Other aspects which are attractive to industrialists are: low sludge production; ability of biomass to lie dormant for several months and then be fully operational; capability of operation on a stop/start basis; no environmental nuisance; low nutrient requirement; high organic throughput; automatic biological overload control facility; measurable and identifiable intermediate products; and a technology similar to that which exists in the food and beverage industry. Developments by Biomass International have evolved a comparatively low cost but effective method of designing and operating an anaerobic packed bed reactor (APBR). Two units are now in operation. The units consist of an upflow, packed bed reactor using a specially developed medium. The basis of each system is that low grade heat wasted from the factory is used for maintaining the reactor temperature at 35 C while the methane produced during digestion is used by the industries concerned as a high grade source of energy. The units treat: wastewater from a confectionery factory; wastewater from a molasses distillery ethanol plant; and wastewater from edible oil production.
W85-05281

MEMBRANE-ENHANCED ANAEROBIC DIGESTERS,
Abcor, Inc., Wilmington, MA.
W. T. Choate, D. Houldsworth, and G. A. Butler.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 661-666. 5 Fig.

Descriptors: *Membrane processes, *Food processing wastes, *Wastewater treatment, *Industrial wastewater, *Anaerobic digestion, Organic wastes, Retention time, Biomass, Chemical oxygen demand, Flour, Wheat.

Anaerobic processing is a simple and energy efficient means of treating and stabilizing many high strength organic wastes. The variable most significant in controlling anaerobic process performance and stability is the solids retention time (SRT). Most of the anaerobic process design improvements have concerned themselves with retaining suspended biomass and organic solids to increase the SRT relative to hydraulic retention time (HRT). The operation of a commercial anaerobic reactor that was retrofitted with ultrafiltration for solids and dissolved solids retention and expands on the potential use of membranes in the anaerobic field is presented. The Tenstar Products Ltd. factory processes 400-450 ton/week of wheat flour. The wastewater stream has a pH of 3.2-3.4 and 1.4% total solids, of which only 0.2% is suspended. The waste stream's COD averages 17,000 mg/l. A commercial scale tubular ultrafiltration plant was designed to operate on the effluent of one compartment within the main tank. This ultrafiltration plant was designed to increase the SRT while the HRT would remain at 4.5 days. The gas production from this plant is approximately 1000 cu m/day, approximately half of which is methane. A seasonal effect appears in the digester/ultrafilter system when the oil level in the flour feedstock for the factory increases. Normal cleaning of the ultrafiltration plant is by means of caustic soda and hypochlorite and has been performed on the average of once per month. Ultrafiltration has improved Temstar's existing digester operation.
W85-05282

DORR-OLIVER'S FIXED-FILM, SUSPENDED-GROWTH ANAEROBIC SYSTEMS FOR INDUSTRIAL WASTEWATER TREATMENT AND ENERGY RECOVERY,
Dorr-Oliver, Inc., Stamford, CT.
P. M. Sutton, A. Li, R. R. Evans, and S. R. Korchin.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 667-675. 5 Fig, 3 Tab, 10 Ref.

Descriptors: *Food processing wastes, *Dairy industry, *Wastewater treatment, *Industrial wastewater, Anaerobic digestion, Chemical oxygen demand, Retention time, Biological oxygen

demand, Hydrogen ion concentration, Grain processing.

Dorr-Oliver's fixed-film and suspended-growth anaerobic systems are discussed and a report on pilot-plant and full-scale application of the systems of treatment of wastewater from the grain process and dairy industries is presented. The Anitron system configuration is an adaptation of the fixed-film biological reactor. The characteristics of an anaerobic process favor application of fixed-film reactors, and particularly the Anitron system, over most suspended growth alternatives in the treatment of soluble high-strength (COD approximately 3000-15,000 mg/l) organic wastewaters. The slow growth rate of the methane bacteria necessitates maintenance of reactor solids retention (SRT) generally in excess of 10-15 days. Dorr-Oliver's patented Membrane Anaerobic Reactor System is an adaptation of the suspended-growth anaerobic process in which ultrafiltration is employed as the solid-liquid separation step. A soy processing company, in cooperation with Dorr-Oliver, conducted an Anitron system pilot-plant study involving operation of a single-stage fluidized bed reactor. The full scale plant consists of four 6.1-m (20-ft) diameter by 12.5 m (41-ft) high reactors with a design capability of removing 8165 kg BOD/day (19,000 lb/day). The pH of the reactors is controlled between 6.8 and 7.2 by use of a chemical feed system for automatic pH monitoring and caustic addition. The system is capable of reaching a volumetric loading rate of 16 kg COD/cu m-day in less than 1.5 months from initial startup. The system is capable of achieving in excess of 95% BOD removal and can be economically operated.
W85-05283

TREATMENT OF DYE AND PIGMENT PROCESSING WASTEWATER BY THE ACTIVATED SLUDGE PROCESS,
Environmental Protection Agency, Cincinnati, OH. Hazardous Waste Engineering Research Lab.
G. M. Shaul, M. W. Barnett, and K. A. Dostal.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 677-689. 5 Fig, 7 Tab, 18 Ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Dye industry Wastes, Pigments, Activated carbon, Retention time, Chemical oxygen demand, Activated sludge process, Gas chromatography.

In this ongoing treatability study, a dye and pigment processing wastewater was treated using powdered activated carbon (PAC) addition to both plug flow and complete mix pilot activated sludge systems which were operated at one solids retention time (SRT) (7-10 days) and 3 different PAC dosages. Addition of PAC to experimental units at a dosage greater than 1000 mg/l resulted in complete color removal, COD removals of approximately 96%, acute toxicity reduction, enhanced sludge settleability and increased system stability in both complete mix and plug flow units. Only slight differences in organics and color removal were observed between the PAC doses of 1000 and 1800 mg/l. It was also observed that PAC addition was not able to reduce influent TOC to less than approximately 80 mg/l SOC in the effluent. The complexity of the wastewater and the characteristics of PAC/activated sludge process (ASP) systems resulted in significant operational and analytical problems. High total suspended solids in the reactor created problems with obtaining representative samples and in analysis of these samples. The execution of the methods requires a more concentrated effort to provide meaningful data. No single gas chromatography methodology exists for such diverse wastewater.
W85-05284

OPTIMIZATION OF SECONDARY COOLING WATER FILTRATION IN A CONTINUOUS STAINLESS STEEL CASTING PROCESS,
Pennsylvania State Univ., University Park.
S. D. Roser, D. A. Long, and J. A. Vaughn.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 691-707. 22 Fig, 2 Tab, 4 Ref.

Descriptors: *Steel industry, *Wastewater treatment, *Industrial wastewater, Cooling water, Filtration, Effluents, Filtration, Suspended solids, Steel, Stainless steel, Casting.

Carpenter Technology Corporation of Reading, PA, operates a stainless steel continuous casting machine. The continuous casting of steel is a metallurgical process in which molten steel is converted into semifinished shapes which then are reheated and converted by reduction mills into finished products. A pilot plant unit was installed to determine an optimum combination of hydraulic loading rate and media. The control pilot sand filter exhibited equal or better effluent quality compared to that from the full scale filters. The dual medium pilot filter produced an effluent quality inferior to that of the single medium pilot filter at all hydraulic loading rates where turbidity was used as a measure of effluent quality. If minimum effluent turbidity is desired, there is no advantages in using dual medium filters over the existing single medium sand filters for this particular application. If the effluent quality obtained from both filters during the study would meet process requirements, then dual medium filtration would offer the advantage of longer filter runs. The percentage of influent turbidity removed by the single medium sand filters increased as the influent turbidity increased. The pilot unit produced similar quality effluent in terms of suspended solids when loaded with both media I and II at all filtration rates investigated. The quality of effluent was statistically the same at filtration rates of 15 and 10 gpm/sq ft and th effluent quality was best at a filtration rate of 5 gpm/sq ft for medium I. The quality of effluent decreased with increasing filtration rate for medium II.
W85-05285

OPTIMIZATION AND CONTROL OF THE ACTIVATED SLUDGE TREATMENT PROCESS BY QUASICONTINUOUS OPERATION: CONCEPT, STRATEGY AND RESULTS,
Karlsruhe Univ. (Germany, F.R.).
R. Staud, P. A. Wilderer, and L. Hartmann.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., MA, 1983. p 709-718. 15 Fig, 1 Tab, 7 Ref.

Descriptors: *Wastewater treatment, *Activated sludge process, Aeration, Biological oxygen demand, Pollumat method.

To achieve a decrease of the amplitude of the diurnal and weekly oscillations of the food-to-microorganism (F:M) ratio, it is suggested that the number of aeration tanks to be kept in service be varied. Tanks which are actually not needed, and which, therefore, are brought out of service for an intermediate period of time are kept under anoxic conditions, thereby conserving the metabolic capacity of the biocommunity, and saving energy. The accomplishment of this treatment method calls for an appropriate analytical method to monitor the influent substrate concentration, i.e., the concentration of organic material which actually is converted by the activated sludge microbes present. The plateau-BOD is suggested as a reasonable parameter. A technique is described (Pollumat method) which was developed to measure the plateau-BOD within a time period of less than 60 minutes. This method needs still operator assistance, however. To lessen the dependence on actual analysis an empirically determined standard graph was developed based on the typical progress of the plateau-BOD values during a week. This standard graph proved to be applicable. Full-scale experiments were conducted at the Schwetzingen wastewater treatment plant to check the feasibility of the methods. The treatment process was controlled without any major problem. The energy demand for aeration was decreased to about 50%; the process efficiency was hardly changed; sludge bulking problems were decreased. Based on a comparison of this method with the sequencing batch reactor technology advantages.
W85-05286

ANAEROBIC TREATMENT OF THERMAL SLUDGE CONDITIONING LIQUOR WITH FIXED-FILM AND SUSPENDED-GROWTH PROCESSES,
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
E. R. Hall, and M. Jovanovic.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 719-728. 10 Fig, 5 Tab, 14 Ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Sludge, Methane, Chemical oxygen demand, Effluents, Biomass.

Pilot-scale high-rate anaerobic methane reactors demonstrated 50-76% COD removal at volumetric organic loadings of up to 33 kg COD/ cu m-day during the treatment of thermal sludge conditioning supernatant. Although the shortest start-up times and highest volumetric removal rates were achieved with fixed-film processes, the maximum removal rates observed in 2 of the reactors were reduced significantly by the low voidage support media used. In addition, the high liquid recycle rates required to maintain expansion in the fluidized bed resulted in lowered biomass accumulation and reduced COD removal efficiencies. The sludge blanket system seeded with digester sludge was not successful in treating thermal conditioning liquor at loadings comparable to the fixed-film reactors. The poor settling characteristics of the UASB biomass produced with this waste contributed to frequent solids loss in the reactor effluent. Effluent and biogas quality were influenced by the mode of operation, the operational maturity of the anaerobic system, and to a lesser extent by the reactor configuration.
W85-05287

RESPONSE OF METHANE FERMENTATION TO CONTINUOUS ADDITION OF SELECTED INDUSTRIAL TOXICANTS,
Drexel Univ., Philadelphia, PA.
G. F. Parkin, and S. W. Miller.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. p 729-743. 7 Fig, 6 Tab, 22 Ref.

Descriptors: *Wastewater treatment, *Fermentation, *Methane, *Retention time, Ammonia, Copper, Nickel, Chloroform, Acclimation, Industrial wastes.

The magnitude of the effect of solids retention time (SRT) on response patterns is dependent on toxicant type, concentration, and temperature. The effect appears to be a complex interaction of cell age, biomass concentration, and toxicant concentration. In general, the longer SRT (25 and 50 days, compared with 15 days) gave the least severe responses. The preferred temperature for tolerating toxicant exposure varies with the nature of the inhibitor; the temperature most often resulting in the least severe responses was 35 C. Significant acclimation to ammonia-nitrogen, copper, nickel, chloroform, formaldehyde and hydrazine was possible through continuous addition of these materials. The magnitude of the lethal dose was a function of SRT, temperature, and initial toxicant concentration. For experimental conditions tested, conditions yielding the best potential for acclimation were 25 or 35 C and 50-day SRT for ammonia-nitrogen, 25 C 50-day SRT of 35 D and 25-day or 50-day SRT for copper, 25 C and 50-day SRT or 35 C and 25 day SRT for nickel, 25-day SRT at 25 or 35 C for chloroform, 35 C and 50-day SRT for formaldehyde, and 35 C and 25-day SRT for hydrazine.
W85-05288

IRON OXIDATION IN INDUSTRIAL WASTE STREAMS,
Duncan, Lagnese and Associates, Inc., Pittsburgh, PA.
W. R. Kelly, and M. Olthof.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 745-751. 8 Fig, 2 Tab, 7 Ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Oxygen transfer, *Iron, Hydrogen ion concentration, Oxidation.

The oxidation rate of iron for industrial wastewaters is, in most cases, only of academic interest. For practical purposes the rate limiting step is the oxygen transfer when the pH is controlled at levels above 8.0. The reaction rate for iron oxidation is only of importance in natural waters where the iron concentration is relatively low. The use of sodium carbonate as a neutralization agent can have an adverse effect on the rate of iron oxidation when compared with hydroxide neutralization agents. It is recommended to verify that the reaction from ferrous to ferric iron is not adversely affected by some interferences present in the wastewater. Therefore, on each waste stream oxygen uptake rates should be performed. However, in most cases the effect will likely be minimal as far as sizing the aeration basin is concerned. The maximum iron oxidation rate that can be obtained through aeration in a tank is about 100 mg/l-min based on the limits of oxygen transfer equipment.
W85-05289

THERMOPHILIC TREATMENT OF A HIGH-BIOCHEMICAL OXYGEN DEMAND WASTEWATER: LABORATORY, PILOT-PLANT AND DESIGN,
Idaho Univ., Moscow. Dept. of Chemical Engineering.
M. L. Jackson.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 753-763. 7 Fig, 14 Ref.

Descriptors: *Pulp and paper industry, *Wastewater treatment, Biochemical oxygen demand, Thermophilic bacteria, Suspended solids, Effluents, Fermentation.

An industrial plant employing corrugated boxes in a recycle operation to produce a liner for reuse produces an effluent at elevated temperatures and relatively high BOD concentrations. The existence of colloidal materials in the original wastewater and laboratory effluent led to the operation of a small pilot unit to assess flocculation and solids separation behavior. An extensive laboratory study was conducted in a 10-liter fermenter at 53 C without solids recycle for which the cell residence time (CRT) is equal to the hydraulic residence time (HRT). The wastewater was received at intervals over a period of a year and varied in composition from 2130 to 2300 mg/l of BOD for 7 barrels with higher values for 2 others. The high concentrations of suspended solids at long CRT showed a consistent performance. A study was conducted employing direct input of wastewater from the discharge line of the box recycle plant. The purpose was to stimulate operation with recycle of cell solids and with input of fiber solids, and to evaluate solids flocculation and separation by flotation. The pilot unit consisted of a 200-gal stainless steel reactor with a settling clarifier for returning some of the cell solids. The BOD removal percentages approximate those for the laboratory study. For medium cell residence times at least 85-90% BOD reductions can be expected. The flotation and settling tests indicated that good solids separation by flotation is attainable even at fairly substantial suspended solids concentration.
W85-05290

AIR STRIPPING OF TRACE VOLATILE ORGANICS FROM WASTEWATER,
Camp, Dresser and McKee, Inc., Boston, MA.
T. Pekin, and A. Moore.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 765-771. 3 Fig, 4 Tab, 3 Ref.

Descriptors: *Wastewater treatment, *Organic wastes, Air stripping, Methylene chloride, (1,1,1)-Trichloroethane, Trichloroethane, (1,2)-Dichloropropane.

Data from pilot plant studies that were completed to demonstrate the effectiveness of using air stripping for removal of certain trace volatile organics are presented. The efficiency of air stripping of organics can be predicted once the Henry's law constant (H) and the air-to-water ratio in the stripping process are known. One factor that influences the design of an air stripping system is the rate of transfer of the volatile organics from the water to air. Henry's law only describes the equilibrium distribution of a volatile organic between the liquid and the gas phase, not the length of time it will take to reach this distribution. The pilot plant was constructed so that it can be operated either as a diffused air or packed tower system. Removal efficiencies predicted by Henry's law constants and air-to-water flow ratios for the parameters of interest were verified in general by the pilot air stripping experiments. However, theoretial efficiencies should be used only as an indication of potential process feasibility, because there is not sufficient field data to establish a mathematical relationship between the theoretical and actual removals. Feasibility of air stripping was verified for the purposes of the project.
W85-05291

VARIABILITY ANALYSIS DURING BIOLOGICAL TREATABILITY OF COMPLEX INDUSTRIAL WASTEWATER FOR DESIGN,
Oklahoma State Univ., Stillwater.
E. L. Stover, D. E. McCartney, F. Dehkordi, and D. F. Kincannon.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 773-783. 7 Fig, 4 Tab, 5 Ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Activated sludge process, Variability, Gas chromatography, Kinetics, Retention time.

Bench-scale, continuous-flow, complete-mix activated sludge reactors were used to treat a synthetic wastewater containing chemicals normally present in chemical, plastics, petrochemical and petroleum industry wastewaters. The influent wastewaster flowrates were regulated to provide hydraulic retention times of 8 hours in the activated sludge reactors. The influent air and offgas were measured and controlled with air flow meters. The offgas was pulled by vacuum pumps through purge traps containing 6 inches of Tenax and 4 inches of silica gel for gas chromatograph analysis. A minimum of 3 individual activated sludge systems were acclimated to each synthetic wastewater. The variability analysis approach presented indicated that Kd was a true biokinetic constant, mu(max) was also treated as a true biokinetic constant, and since mu(max) equals K times Yt, and Yt was found to be a variable biokinetic coefficient, mu (max) and K could not both be treated as constants. If Yt equals mu (max)/K varies, mu (max), K, or both must vary. If both mu (max) and K vary, the prediction of these coefficients becomes more difficult. The decision to make mu (max) a biokinetic constant and K a variable biokinetic coefficient depending on the variable biokinetic coefficient Yt simplifies the prediction of mu (max) and K.
W85-05292

DESIGN-ORIENTED REVERSE OSMOSIS MODEL,
Toledo Univ., OH.
J. F. Metzger, and D. Angelbeck.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 785-794. 2 Tab, 9 Ref.

Descriptors: *Reverse osmosis, *Design standards, Industrial wastewater, Model, Membrane processes, Fluctuations.

A model describing the reverse osmosis process is presented and tested against reverse osmosis data contained in the literature. The mass flux of a chemical species across a given surface area of membrane may be attributed, as in Fick's law, to a permeability coefficient of that species and a concentration gradient. Likewise, water or solvent flux through the membrane may be related to a pressure gradient across the membrane and a water permeation coefficient. If the solute flux is divided by the solvent flux, a dimensionless mass ratio of the solute to solvent leaving the membrane surface is obtained at any increment of time. To evaluate the model's ability to predict the performance of actual reverse osmosis systems, certain data for presently operating systems was input into the model. The model's output was then compared with the corresponding measured conditions of the operating system being considered. A comparison of the predicted and observed pressure values show that, with some exception, a maximum and minimum pressure discrepancy of plus or minus 10% generally exists with respect to observed operational pressures. These discrepancies should be acceptable for most design purposes, especially for conceptual designs where discrepancies approaching 50% are not uncommon. An industrial waste is a candidate for treatment by reverse osmosis with a membrane of unknown properties.
W85-05293

REMOVAL PATHWAYS AND FATE OF ORGANIC PRIORITY POLLUTANTS IN TREATMENT SYSTEMS: CHEMICAL CONSIDERATIONS,
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
M. P. Strier, and J. E. Gallup.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 813-823. 5 Tab, 14 Ref.

Descriptors: *Wastewater treatment, *Wastewater facilities, *Activated sludge process, *Organic wastes, Adsorption, Chemical reactions, Air stripping, Biochemical oxidation, Polychlorinated biphenyls, Chlorinated hydrocarbons, Phenols, Biodegradation, Phthalate esters.

The physical and chemical properties of organic pollutants coupled with the chemical nature of their water matrix govern their behavior and fate during treatment of primary effluent by activated sludge. There are basically 4 removal pathways possible during activated sludge treatment with only one most likely predominating for any one pollutant at any one point in time. These removal pathways consist of adsorption, air-stripping, biochemical oxidation and chemical reaction. Adsorption and air-stripping are nondestructive; biochemical oxidation and chemical reaction are destructive. Generally, larger, unreactive, polarizable and insoluble molecules are the most adsorptive, i.e., PCB, PNA (PAH) and phthalate esters. Smaller, volatile and less soluble molecules are most air-strippable, i.e., halogenated methane (fluorinated or chlorinated). Reactive aromatics of intermediate solubility, provided they possess no more than one substituted chloro- or nitro-group (applies strictly to priority pollutants) are highly biodegraded. Phenol is a good example. Certain compounds are so highly chemically reactive that they will chemically degrade or transform instantaneously prior to biodegradation. Certain substituted phenolics are examples. Adsorptive and chemical reaction pathways appear to be the most rapidly occurring and dominating processes, when conditions are most favorable for them. Air-stripping is next and finally biochemical oxidation is the slowest and least dominating of the four removal pathways. Compound solubility in water is a governing factor in establishing its removal pathway from water.
W85-05294

TREATMENT OF CORK-STOPPER MANUFACTURING WASTES,
Newcastle upon Tyne Univ. (England). Public Health Engineering Div.
G. K. Anderson, C. Y. Cheng, and A. C. Pinto.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 825-831. 2 Fig, 2 Tab, 2 Ref.

Descriptors: *Cork industry, *Wastewater treatment, *Industrial wastes, Effluents, Sludge, Acids, Dyes, Aeration, Biological treatment, Cork stoppers.

A comprehensive but preliminary investigation into the treatment and disposal of wastewaters from the cork-stopper production industry is presented. Due to the nature of the manufacturing

operations, a large proportion of the wastewater consists of the discharge of spent processing fluids which will normally be only once per week. Two schemes have been suggested and are being considered for further investigation at a pilot scale. In both schemes, boiling tank effluent, oxalic acid and dyeing solution, and chlorinated lime slurry would go to their own equalization tank. In one scheme, nutrients would be added to the boiling tank effluent for biological treatment, to sludge or batch coagulation, to sludge or flow equalization, through pH adjustment, and then to the rivers. Oxalic acid and dyeing solution and chlorinated lime slurry would go from their own equalization tanks to the neutralization and then to either biological treatment or batch coagulation and then, ultimately, to the river. In the other scheme, the boiling tank effluent would go from the equalization tank to the batch coagulation and then to either sludge or supernatant storage, batch neutralization, and either sludge or sewer. Oxalic acid and dyeing solution and chlorinated lime slurry would go directly to batch coagulation and then to either sludge or sewer. A pilot scale biodisc has been constructed and installed on site and is being used to confirm laboratory data and to derive full scale design data. The extended aeration unit pilot plant is being designed and constructed to operate alongside the biodisc. A technician training scheme is being developed to improve wastewater technology in Portugal.
W85-05295

TREATMENT OF SPENT DETERGENT SOLUTION CONTAINING MONOETHANOLAMINE,
Western Electric Co., Inc., New York.
E. T.-Y. Lee, and T. A. Hunter.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 833-839. 1 Fig, 5 Ref.

Descriptors: *Wastewater treatment, *Detergents, *Activated sludge process, Aeration, Waste disposal.

Discharge of aqueous detergent cleaning waste containing about 40 lb MEA/day into an activated sludge extended aeration sewage plant treating 200,000 gal/day caused significant plant upsets and the discharge had to be discontinued. Detergent waste containing MEA interferes with conventional metal hydroxide precipitation process by forming soluble metal complexes. Treating MEA waste with hypochlorite in the presence of soluble calcium is feasible. This is verified by a nearly complete reduction of the waste's complexing ability after hypochlorite treatment. More analytical work is needed before and after the hypochlorite treatment to verify the completeness of the reactions and to determine the final products and their oxygen demand and toxicity. While the use of aqueous detergent cleaners and other water soluble solutions in manufacturing processes provide certain advantages over the replaced solvent operations, the availability of their disposal alternatives and associated costs, whether it is a discharge into a municipal sewer system or an onsite treatment approach, should be investigated before switching from solvent to aqueous type operation. For industrial users who have to discharge directly into waterway, the disposal alternatives are further limited. Due to the wide variety of organic chemicals used in aqueous solutions, a chemical/physical treatment process may prove to be very complex and costly.
W85-05296

COMPUTER CONTROL OF A SMALL WASTEWATER TREATMENT PLANT,
Loftus (Peter F.) Corp., Chicago, IL.
R. Seksaria, D. B. Corkle, and R. E. Schwab.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 841-846. 4 Ref.

Descriptors: *Wastewater treatment, Oily water, Computers, Chromates, Cooling towers, Boiler water.

Computers provide exceptional controller versatility, replace conventional control room instrumentation and reduce operating costs through process optimization. How the computer was applied as a useful tool for operating 2 treatment systems is demonstrated and additional feature that a computer can provide are discussed. All oily wastewater from the manufacturing processes except for coolants is collected and pumped to the waste treatment facility. Free oil is skimmed from the plate separator and concentrated. Chromate containing wastewater from the cooling towers and heating plant waste containing boiler blowdown and softener regenerant flow through an equalization tank into a compartmentalized treatment tank where sulfuric acid, ferrous sulfate and caustic soda are added in succession. Because the treatment processes are fairly complex, requiring monitoring and controlling of many process variables, conventional control systems would have required approximately 65 current switches, 40 indicators, 75 alarms, 12 recorders, 20 controllers, 2 totalizers, 3 alternators and 15 relays for monitoring the process alone. A single computer replaced all of this conventional instrumentation. The computer also operates and monitors the status of approximately 40 pumps, 25 equipment drives, and 30 automatic valves, and performs other specialized functions. In the oily wastewater treatment system, the computer calculates the running times for the various chemical feed pumps depending on the chemical dosage rate and volume to be treated and operates them in sequence for the required amount of time.
W85-05297

ENHANCED BIOLOGICAL TREATMENT OF LEACHATES FROM INDUSTRIAL LANDFILLS,
Notre Dame Univ., IN.
R. L. Irvine, S. A. Sojka, and J. F. Colaruotolo.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 861-870. 4 fig, 9 Tab, 3 Ref.

Descriptors: *Leachates, *Landfills, Industrial wastewater, Biological treatment, Effluents, Cost analysis, Activated carbon, Organic carbon.

The technical steps take by Occidental Chemical Corporation to treat the leachate collected at the Hyde Park Landfill site are presented. The site consists of a tile leachate collection system, an improved clay cap and treatment of leachate by activated carbon. The present treatment of Hyde Park leachate by conventional carbon technology, although producing a suitable quality effluent, is unacceptable from an economic and technical reason. Two sets of biological studies were conducted. The first set operated for approximately 50 days. Two reactors were maintained with both reactors receiving nonsterile raw waste feed (NSRWF) but with one reactor having Hooker organism HCV (2,6 DCT), referred to as SS3, added on every fifth day. SS3 and similar organisms may be of value in future treatment operations, but will require additional research before benefits can be expected from their use. The major conclusion that can be drawn from this study is that Hyde Park leachate is easily treated biologically in a sequencing batch reactor (SBR). Because of the turbid nature of the effluent, any full scale application of the SBR should include a filter or some other similar solids separation device. Further TOC removal from the filtered SBR effluent can be accomplished readily in the existing (or expanded) activated carbon facilities if future effluent limitations demand more extensive treatment. The use of biological waste treatment in the SBR is expected to result in a substantial savings in cost.
W85-05299

LAND TREATMENT OF MUNICIPAL WASTEWATER: SELECTED EXAMPLES IN THE UNITED STATES,
Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
F. M. D'Itri, H. Bouwer, Y. A. Demirjian, T. P. Smith, and W. G. Leseman.
In: Symposium on the Treatment and Reuse of Industrial and Municipal Wastewater, March 24, 1982, Mexico City (Mexico). 34 p, 5 Fig, 12 Tab, 27 Ref.

Descriptors: *Spray irrigation, *Land disposal, *Wastewater disposal, *Wastewater irrigation, *Wastewater renovation, *Wastewater management, *Biological treatment, Recycling, Municipal wastes, Wastewater treatment, Phosphorus, Nitrogen, Infiltration.

Four wastewater land disposal programs in the United States that have been successfully operating for several years in the disposal of municipal wastewater are described. The Flushing Meadows project of Phoenix, Arizonia examined the renovation of wastewater by groundwater recharge through rapid infiltration basins in the Salt River bed 2.4 km downstream from the 91st Avenue Sewage Treatment project. The project ran from 1967 to 1978. The renovated wastewater contained acceptable levels of N, P, BOD, and heavy metals and showed effective removal of fecal coliforms and viruses. The 23rd Avenue project initiated in 1974 in the City of Phoenix in response to the favorable results of the Flushing Meadows project, tested the effects of increased levels of algae in the sewage effluent and increased hydraulic loading on the infiltration system. The project covered a larger infiltration area and produced enough renovated water for commercial reuse by an irrigation district. The Tallahassee spray irrigation project started in 1966 with the use of treated effluent from the Tallahassee Southwest Wastewater Treatment Plant. In 1971, effluent overload from the Lake Bradford Plant was pumped to the Southwest plant for spray irrigation. Irrigated plots were seeded with Bermuda grass and rye grass to reduce N levels. The Mushegon County Wastewater Management System No. 1 in Michigan is one of the few full scale spray irrigation land treatment facilities in the United States. The wastewater is delivered to sandy, unproductive land (4,455 ha) via six pumping stations. The combined wastewaters are treated biologically in three aerated lagoons.
W85-05324

CONCENTRATING WHEY BY HYPERFILTRATION AT A SMALL CANADIAN CHEESE PLANT.
Technology Development Report EPS 4-EP-83-2, July 1983. 84 p, 44 Fig, 28 Tab, 12 Ref.

Descriptors: *Dairy industry, *Hyperfiltration, Wastewater treatment, Water pollution control, Pollution load, Whey, Cheese.

Whey from cheese making operations, if simply discharged to the aquatic environment, exerts an extremely high pollution load. While large cheese making plants have been able to incorporate various recovery, reuse, and treatment schemes, no cost effective method of handling whey has been available to smaller operations. This report describes the application of a hyperfiltration system for concentrating the solids in sweet whey at La Fromagerie d'Oka, Oka, Quebec, a cheese making plant with a production of 4256 kg/d. Hyperfiltration offered the potential for recovery of a whey concentrate which could be used in the manufacture of edible products, while also reducing the pollution load from the cheese plant. The results of a 592-day evaluation of the system showed that whey could be concentrated from an initial 6.24% solids to 24.1% solids, with a high recovery of protein and minerals. At the same time, major pollutant parameters in the raw whey were reduced by more than 95%. The payback period for the hyperfiltration system was calculated at 14 months when savings in wastewater treatment are considered and the concentrated whey is given away free of charge. If the whey were to be sold, the payback period would decrease proportionally with the amount of revenue recovered. The study recommends that hyperfiltration for whey concentration be considered in any economic evaluation of pollution abatement/by-product recovery schemes for cheese making plants of similar size, taking into account the site-specific characteristics of the operation.
W85-05331

PILOT SCALE INVESTIGATION OF COMPUTERIZED CONTROL OF THE ACTIVATED SLUDGE PROCESS,
Environmental Protection Service, Ottawa (Ontario).
J. P. Stephenson, B. A. Monaghan, and L. Y. Yust.
Report SCAT-12, 1982. 118 p, 56 Fig, 28 Tab, 47 Ref.

Descriptors: *Pilot plants, *Activated sludge process, *Dissolved oxygen, Hydrogen ion concentration, Suspended solids, *Organic carbon, *Sludge, Contact stabilization process, Temperature, Liquid flow, Air flow, Modelling, Canada.

A pilot plant evaluation of the feasibility of using on-line instrumentation and an automated data acquisition system to continuously monitor parameters within the activated sludge process is described. Also investigated was the extent to which it is technologically and economically possible to use an automated system to assist the plant operator in controlling the activated sludge process. Instruments selected for evaluation included sensors for dissolved oxygen, suspended solids, pH, temperature, liquid flow, air flow, and total organic carbon. Sensor precision and accuracy were assessed in comparison to standard reference techniques, and maintenance and calibration requirements were determined. The pilot plant instrumentation was interfaced with a minicomputer data acquisition and control system which was provided with sufficient capacity and peripheral devices to permit activities such as modelling and data analysis.
W85-05333

ORGANIC CONTAMINANT BEHAVIOR DURING RAPID INFILTRATION OF SECONDARY WASTEWATER AT THE PHOENIX 23RD AVENUE PROJECT,
Stanford Univ., CA. Dept. of Civil Engineering.
E. J. Bouwer, M. Reinhard, and P. L. McCarty.
Agricultural Research Service, Technical Report No. 264, March, 1982. 88 p, 8 Fig, 10 Tab, 39 Ref, 6 Append.

Descriptors: *Wastewater treatment, Secondary wastewater treatment, *Rapid infiltration, *Percolation, *Chlorination, Wastewater, Secondary wastewater, Infiltration, Aliphatic hydrocarbons, Hydrocarbons, Benzenes, *Path of pollutants, Arizona.

Organic trace contaminants were removed to varying degrees during rapid infiltration of secondary treated wastewater for groundwater recharge at the 23rd Avenue Rapid Infiltration Project in Phoenix, AZ. Samples of the wastewater applied to the spreading basins and of renovated water taken from monitoring wells were characterized for specific organic pollutants using gas chromatography/mass spectrometry. The study was divided into two sampling periods of three months each. During the first period, nonchlorinated secondary wastewater was applied to the basins. During the second period the system was operated with chlorinated wastewater. Chlorination of the secondary wastewater with 1.5 milligrams/l Cl had little effect on the organic compounds identified and their concentrations in the secondary wastewater and renovated water. Nonhalogenated aliphatic and aromatic hydrocarbons and the priority pollutants ethylbenzene, napthalene, phenanthrene, and diethylphthalate were removed with high efficiecy during soil percolation, but many of the compounds could still be detected in the underlying groundwater. Volatilization losses were important for the low-molecular weight volatile compounds as water moved across the basin. Biodegradation and sorption processes appear to be responsible for the decreased organic concentrations in the renovated water resulting from soil passage. Both aerobic and anaerobic processes were probably active.
W85-05335

PROCESS DESIGN MANUAL FOR DEWATERING MUNICIPAL WASTEWATER SLUDGES,
Culp/Wesner/Culp, Santa Ana, CA.
R. C. Gumerman, and B. E. Burris.
Report EPA-625/1-82-014, October 1982. 207 p, 65 Fig, 41 Tab, 122 Ref, 3 Append.

Descriptors: *Sludge, *Municipal wastewater, *Dewatering, Cost analysis, Filters, Centrifugation, Vacuum filtration, Pressure filtration, Drying, Sludge lagoons.

A critical review of municipal wastewater sludge dewatering process technology is presented. Particular emphasis is given to the development of a procedure for the selection and design of a dewatering process. Included in the manual are discussions of sludge characteristics, dewatering processes, their performance capabilities and operational variables, chemical conditioning cost and energy considerations, and case study information. Dewatering processes discussed are basket centrifuge, low G and high G solid bowl centrifuges, belt filter presses, drying bed, sludge lagoon, and gravity/low pressure devices.
W85-05352

FIFTH ANNUAL MADISON CONFERENCE OF APPLIED RESEARCH AND PRACTICE ON MUNICIPAL AND INDUSTRIAL WASTE.
Wisconsin Univ.-Extension, Madison. Dept. of Engineering and Applied Science.
September 22-24, 1982. 651 p, 210 Fig, 121 Tab, 388 Ref. $25.00.

Descriptors: *Waste management, *Industrial wastes, *Municipal wastes, *Regulations, *Waste disposal, *Land disposal, *Waste recovery, *Solid waste disposal, *Symposiums, Wastewater management, Sanitary landfills, Landfills, Sludge disposal, Wastewater disposal, Water quality control, Recycling, Political aspects, Policy making, Solid wastes.

Promoting technology transfer and resolving the policy issues within the land disposal field remain challenges for professionals involved in municipal and industrial waste management. During the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, specialists in engineering, soils, geology, and related disciplines explored these challenges, reviewed the latest developments in land disposal, and provided insights on future directions. A future forum, eight technical sessions, and two field trips were features of the three-day conference. Four national figures addressed political concerns, regulatory controls, special problems facing solid waste managers, and land application programs for sludge. Technical sessions considered landfill design and operation, groundwater quality protection, management of municipal sludge, leachate, and chemical waste, and land application of industrial wastes. Tours included the Madison Municipal Sludge District Metrogro Program's facilities for the application of sludge on agricultural land and the City of Madison refuse derived fuel plant.
W85-05364

CASE STUDY OF LEACHATE AND GAS MANAGEMENT AT A SANITARY LANDFILL,
Reitz and Jens, Inc., St. Louis, MO.
D. E. Murray.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ.-Extension, Dept. of Engineering and Applied Science, Madison. p 31-35.

Descriptors: *Landfills, *Waste disposal, *Waste recovery, *Odor control, *Land disposal, *Leachate, *Waste management, Odors, Solid wastes, Solid waste disposal, Waste storage, Waste dumps, Wastewater treatment, Wastewater management.

A large sanitary landfill started over 15 years ago which receives over one million cu yards/yr has recently had problems with leachate collection and disposal and control of gas odors. It was decided to develop an onsite leachate treatment facility consisting of chemical and biological treatment units and settling lagoons. Effluent from the settling lagoons goes through a meter manhole into the Metropolitan Sewer District sewer. As the landfill needed to expand, a quarry pit was approved as an appropiate site for the expansion if a holding lagoon could be provided for the leachate accumulated in the bottom of the quarry pit. Leachate transferred to the holding lagoon would be treated by the landfill leachate treatment facility. The gas odor problem was controlled by application of daily cover over the active landfill area and application of a chemical to the leachate lake surface to retard evaporation. A gas burner unit was also built to collect and burnoff the landfill gases. The satisfactory performance of this unit has resulted in the development of a larger burner assembly for gas recovery.
W85-05365

CHOOSING SEWAGE ASH DISPOSAL SITES IN THE TWIN CITIES METROPOLITAN AREA,
Metropolitan Council, St. Paul, MN.
J. L. Frost, R. W. Thron, D. J. Knuth, and E. A. Hickok.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ.-Extension, Dept. of Engineering and Applied Science, Madison. p 59-78, 1 Fig, 4 Tab, 3 Ref.

Descriptors: *Landfill, *Sludge, *Minnesota, *Sludge disposal, *Site selection, *Environmental impact statement, *Urban areas, *Public participation, *Urban planning, Decision making, Land use, Land disposal, Solid wastes, Solid waste disposal, Environmental policy, Public policy, Public opinion, Minnesota, Social participation, Public relations, Public rights, Attitudes.

A sewage sludge ash siting process designed to be technically sound and to encourage public participation by stimulating controversy was tried in the Twin Cities Metropolitan Area of Minnesota. The Waste Management Act passed by the Minnesota legislature in 1980 called for public involvement throughout the siting process and directed the Metropolitan Council to guide the siting process. The Council recommended various criteria for public comment and then held a series of public meetings in the Twin Cities Area. This first round of public meetings was attended by only about 100 people. After the Council named 31 potential sites, the next round of meetings drew over 1,700 people. A comprehensive discussion regarding the criteria and related public concerns then took place prior to Council adoption of the criteria. The criteria delineating the optimum site conditions suitable for a sludge ash landfill took into consideration surface water, hydrogeology, surface geology, topography, environmentally sensitive areas, transportation, agriculture, aesthetics, land use, number of property owners, historical or archaeological importance and other factors in the Council Development Guide. Environment impact statements were prepared on six candidate sites and the final site was chosen in the summer of 1983.
W85-05366

DEVELOPMENT OF A SLUDGE/REFUSE CO-DISPOSAL PROGRAM,
Donohue and Associates, Inc., Sheboygan, WI.
For primary bibliographic entry see Field 5E.
W85-05367

LEACHATE DISPOSAL ALTERNATIVES IN A SOLE SOURCE AQUIFER ENVIRONMENT,
Dvirka and Bartillucci, Syosset, NY.
For primary bibliographic entry see Field 5E.
W85-05373

'CONTAINMENT' STRATEGIES TO MANAGE ABANDONED HAZARDOUS WASTE SITES IN A COST EFFECTIVE MANNER,
Weston Environmental Consultants-Designers, West Chester, PA.
For primary bibliographic entry see Field 5E.
W85-05375

FINDING AN ACCEPTABLE APPROACH FOR DISPOSAL OF COAL COMBUSTION RESIDUES IN CALIFORNIA,
Stanley Consultants, Inc., Muscatine, IA.
For primary bibliographic entry see Field 5E.
W85-05376

CASE STUDY OF DESIGN PROCEDURES FOR A LAND TREATMENT OF WASTEWATER SYSTEM, DALTON, GEORGIA,
Golder Associates, Atlanta, GA.
H. M. Gauntt, and G. D. Trott.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison, p 611-621, 2 Fig, 5 Ref.

Descriptors: *Design criteria, *Wastewater management, *Land disposal, *Wastewater disposal, *Waste disposal, *Site selection, *Waste management, *On-site data collections, Soil properties, Water quality, Project planning, Soil chemistry, Percolation rate, Data collections, Hydrologic data collections, Georgia.

The geotechnical investigation conducted to select wastewater management alternatives, in particular, land treatment systems, for the city of Dalton, Georgia was based on guidelines published by the Georgia Environmental Protection Division. These guidelines called for the development of a soil series (type) map with confirmatory boring locations, verification of previously assumed percolation rates, determination of soil chemistry and groundwater flow regimen, and determination of existing groundwater quality to serve as background data for future monitoring programs. Evaluations of the ability of the soil to absorb wastewater were made from USDA Soil Conservation Service data, laboratory permeability tests and field double ring infiltrometer tests. The design team decided on an application rate of 0.16 inches/hr. The joint involvement of geotechnical and sanitary consultants with the regulatory agency proved invaluable in the design and approval processes. The results of all design studies and investigations for the Dalton, Georgia Land Treatment System were design parameters that adequately characterized the site.
W85-05393

PROCEEDINGS, 38TH INDUSTRIAL WASTE CONFERENCE.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
May 10-12, 1983. Butterworth Publishers, Boston, MA, 1984. 1000 p.

Descriptors: *Industrial wastewater, *Conferences, *Wastewater treatment, Chemical wastes, Food-processing wastes, Metal-finishing wastes, Textile mill wastes, Tannery wastes, Oil wastes, Pharmaceutical wastes, Agricultural wastes, Pulp wastes, Paper wastes, Hazardous materials, Toxicity, Powerplants, Coal, Coke, Industrial wastes.

This proceedings volume contains 74 papers relevant to wastewater treatment and pollution control. The papers are classified according to the following general categories: oil wastes, land disposal, paper wastes, agricultural wastes, animal wastes, pharmaceutical wastes, textile wastes, hazardous and toxic wastes, metal wastes, plating wastes, chemical wastes, coal, coke, and power plant wastes, physical/biological systems, food wastes, and miscellaneous.
W85-05396

EVOLUTION OF DESIGN OF FORD MOTOR COMPANY INDUSTRIAL WASTE TREATMENT FACILITIES,
Ford Motor Co., Dearborn, MI.
N. B. Silverson, D. L. Ruch, D. E. Kinnee, and F. L. McAuliffe.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA, 1983. p 13-22, 7 Fig, 3 tab.

Descriptors: *Oil wastes, *Paint wastes, *Heavy metals, *Wastewater treatment, *Metal finishing wastes, Sludge digestion, Sludge treatment, Emulsifiers, Clarifiers, Gravity filters, Separation techniques.

The design approaches taken at Ford in the treatment of oily, paint and heavy metal wastes are described. Oil-laden sludges are treated in a conventional ferric chloride facility with a 'Windsor process' modification. This process utilizes sulfuric acid for low acid digestion of the emulsifiers, calcium chloride and caustic for emulsion breaking and pH adjustment, resulting in the virtual elimination of sludges. Heavy metal/paint waste treatment facilities were first batch treatment tanks and settling lagoons, with the settling lagoons being replaced by clarifiers in later years to increase treatment efficiency and decrease the land area used. A further improvement in this direction is the replacement of clarifiers with parallel plate gravity separators. Care must be taken to properly weatherproof all facilities. A permanent staff should be used so that they will be able to diagnose and treat any emergencies in the system. Automation has so far been impractical due to excessive down time of the automated system requiring manual running of the treatment facility.
W85-05397

OILY WASTEWATER TREATMENT AND THE IMPACT OF HIGH WATER CONTENT SYNTHETIC FLUIDS AT FORD MOTOR COMPANY,
Ford Motor Co., Detroit, MI.
P. R. Lawrence.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA, 1983. p 29-34, 2 Fig, 1 Tab.

Descriptors: *Oil wastes, *High water content fluids, Biological oxygen demand, Chemical oxygen demand, Emulsifiers, Separation techniques, *Wastewater treatment, Biological wastewater treatment.

This paper reports the special attributes of 'synthetic' high water content fluids (HWCF) that replaced petroleum-oil based fluids used for machinery and/or hydraulic applications in Ford plants. HWCF are categorized as semisynthetic or synthetic. Semisynthetic HWCF typically contain from 3% to a maximum of 15% petroleum oil products. Because of the types and quantities of emulsifiers, surfactants and various other ingredients, semisynthetic fluids can be extremely difficult to separate from wastewater and can interfere with wastewater treatment operation. True synthetic coolants, which contain no petroleum oil, do not interfere with effective removal of free and/or emulsified oil that has entered the fluid in the manufacturing process. Because many of the synthetics are composed of polyglycols, alcoholamine salts and other water soluble organics, the COD and BOD of these HWCF are extremely high and must be lowered to meet permit levels. Ford has encouraged suppliers to formulate HWCF that would respond to Ford's conventional oil-water separation treatment techniques. Although biological treatment can eventually oxidize the water-soluble organics, biological treatment facilities cost over $2.5 million each and offer little improvement over the best HWCF fluids combined with the best conventional treatment.
W85-05398

CHEMICAL COAGULATION OF TAR SAND PROCESSING WASTEWATER,
Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
P. H. King, M. O. Akad, and W. F. McTiernan.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA, 1983. p 35-40, 4 Fig, 7 Tab, 8 Ref.

Descriptors: *Wastewater treatment, *Oil wastes, Ferric chloride, Chemical coagulation, Suspended solids, Organic carbon, Sludge, Alum, Lime, Flocculation.

The use of chemical coagulants is a viable treatment of a representative steam-flooding tar sand processing wastewater. Alum, ferric chloride and lime were all effective in removing suspended solids, but the alum system produced a relatively high volume of sludge and the lime system required unusually long periods of time to stabilize the pH and resulted in a substantially poorer removal of soluble total organic carbon content. For these reasons ferric chloride was chosen for more extensive testing. The appropriate dose of ferric chloride is 300 to 450 mg/liter depending on the suspended solids concentration. The system is insensitive to pH in the 4.0 to 5.5 range and to variations in mixing and flocculation rates. Settling and polymers do not enhance either suspended solids or total organic carbon content removal, but do result in some improvements in sludge volume.
W85-05399

WASTEWATER TREATMENT BY OVERLAND FLOW,
Clemson Univ., SC. Dept. of Environmental Systems Engineering.
A. R. Abernathy.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA, 1983. p 47-55, 5 Fig, 6 Tab, 6 Ref.

Descriptors: *Municipal wastewater, *Wastewater treatment, *Overland flow, Biochemical oxygen demand, Suspended solids, Organic carbon, Phosphorus, Ammonia, Nitrate, Nitrogen compounds, Lagoons, Algae, Effluents, Construction costs, Operating costs.

An overland flow facility for treating municipal wastewater in a region of high rainfall, mild climate, and relatively low soil permeability is described. Overland flow was successful in treating comminuted raw wastewater and polishing lagoon effluent. Comminuted raw sewage was converted into an effluent, better than effluents from more traditional secondary treatment plants. Lagoon effluent treated by overland flow gave a final effluent approaching tertiary treatment quality except for the problem of algae cells produced in the lagoon. These algae moved down the plots with the runoff and increased the suspended solids concentration in the plot effluent. Costs for both construction and operation of the overland facility compare favorably with more traditional facilities if land cost is low, energy costs were low, and operating the system basically required keeping the pumps operating, mowing the grass and clearing an occasional plugged spray nozzle or gated pipe opening.
W85-05400

HYDRAULIC LOADING FOR LAND TREATMENT SITES UNDER NON-IDEAL CONDITIONS,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
T. S. Steenhuis, R. C. Loehr, and C. Babajimopoulos.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA, 1983. p 57-65, 12 Fig, 17 Ref.

Descriptors: *Wastewater treatment, *Model studies, *Mathematical models, Model testing, Hydraulic loading, Land treatment, Computer models, Groundwater, Water table rise.

A methodology was developed that may assist in determining the proper hydraulic loading of land treatment systems for wastewater. The method is based on comparing the calculated rise of groundwater mound with surface elevation. Two methods, a finite difference technique and an analytical (or closed form) solution, were used to solve the partial differential equation for groundwater flow and to calculate the mounding. The closed form solution rapidly computes groundwater table elevations and uses a minimum of input data. Spatial variability of input data is not considered. This method is suited for initial screening of land treatment facilities of wastewater where accuracy of

prediction is of little consequence as long as input parameters have a broad error margin. The finite difference technique is the method of choice for detailed design; it considers variability in site specific hydrological parameters. The method is much more computer time intensive than the closed form solution.
W85-05401

INVESTIGATION OF THE POTENTIAL OF AN ENZYMATIC TREATMENT OF PULP AND PAPER MILL EFFLUENT TO FACILITATE DECOLORIZATION BY LIME PRECIPITATION,
North Carolina State Univ. at Raleigh. Dept. of Wood and Paper Science.
J. C. Campbell, and T. W. Joyce.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA, 1983. p 67-73, 8 Fig, 12 Ref.

Descriptors: *Wastewater treatment, *Color removal, *Pulp wastes, Laccase, Quinones, Lime precipitation, Pulp and paper industry, Hydrogen peroxide.

Since increasing the molecular weight of color molecules (quinones, quinonemethides and vinyl groups conjugated with an aromatic ring) by polymerization increases the efficiency of their removal by lime, this study sought to determine if laccase and hydrogen peroxide could increase the effectiveness of lime precipitation of color from several pulp and paper mill effluent types. Pretreatments of three pulp and paper mill effluent types with the enzyme laccase prior to lime addition gave limited or no improvements in color removal efficiency. Spiking biologically treated whole mill effluents with phenolic compounds during pretreatment caused an improvement, but this increase was not substantial enough for industrial significance. An assay for laccase activity in these effluents at pH 5 with added syringaldazine as the substrate indicated that laccase activity could be sustained in the effluents. The inability of laccase to produce the effects desired is probably attributable to insufficient phenolic hydroxyls in the effluents, or to the absence of phenolic compounds having sufficient reactivity with the enzyme.
W85-05402

ENHANCED PRIMARY TREATMENT OF PULPING WASTEWATERS,
Envirotech Corp., Salt Lake City, UT. Eimco Process Machinery Div.
R. W. Okey.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA, 1983. p 75-82, 5 Fig, 12 Ref.

Descriptors: *Wastewater treatment, *Suspended solids, *Pulp wastes, Lignin, Chemical oxygen demand, Effluents, Biological wastewater treatment, Lime, Color removal, Calcium hydroxide.

A problem frequently encountered when pulping wastewater is treated biologically is an unusually high effluent suspended solids level. An attempt was made to intercept the precursor of the lignin-like particle, which is responsible for creating high effluent suspended solids, through the combined use of lime, polymer and neutral calcium. The nature of the reaction when using neutral calcium ion appears to be distinctly different from that seen with lime. Less color (50%) is removed using neutral calcium, while massive lime treatment commonly removes substantial quantities (80-90%) of color. The difference appears to be due partly to the actual quantity of calcium ion available in the system at elevated pH where lime is employed. The color removal reaction is at least in part due to adsorption onto solid phase Ca(OH)2.
W85-05403

COLOR REMOVAL FROM SULFITE WASTES WITH CATIONIC SURFACANTS,
Tennessee Technological Univ., Cookeville. Dept. of Civil Engineering.
K. L. Roberts, and J. Gu Lin.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA, 1983. p 83-88, 4 Fig, 13 Ref.

Descriptors: *Wastewater treatment, *Color removal, *Cationic surfactants, *Pulp wastes, Sulfite wastes, Pulp and paper industry, Sludge, Lime, Alum, Coagulation, Chemical oxygen demand.

The objectives of this study were to determine whether or not a cationic surfacant would effectively remove color from a sulfite mill waste and to compare its efficiency with that of lime, alum, and lime-magnesium. Another objective was to compare the characteristics of the sludge produced by each coagulant. Cationic surfactants are superior to inorganic coagulants in removing color from sulfite waste. For example, Cetol removed 97% of the color at a dose of 1750 mg/l while lime removed only 70% at a dose of 60,000 mg/l. The inorganic coagulants removed more COD than the cationic surfacant. The cationic surfacant-color sludge thickened much more rapidly into a much smaller volume than any of the inorganic coagulant-color sludges. The dewatering characteristics of the sludges were similar. Considerable work, including a pilot scale study, will be required before a meaningful economic analysis of this technology can be completed. Cationic surfacants are relatively expensive compared to alum and lime but considerably less chemical is required. The degree of treatment is much higher, and the sludges produced are much easier to thicken. All of these considerations must be balanced in the final economic analysis.
W85-05404

TOTAL SYSTEMS APPROACH REDUCES MILL WASTEWATER TREATMENT COSTS,
Nalco Chemical Co., Oak Brook, IL.
D. H. Prah, and D. E. Grimestad.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 89-94, 4 Fig, 2 Tab, 1 Ref.

Descriptors: *Wastewater treatment, *Pulp wastes, Solids removal, Costs, Sludge Drying, Cost analysis.

The Total Systems Approach increased profits in one year for one paper mill. By reallocating the expenses (in essence, spending more for electrical power in aeration to maintain mixed liquor dissolved oxygen better) and being more conscious of control of the nutrient feed, savings were realized in sludge dewatering (polymer) and drying (natural gas). The energy recovered by firing these solids in the hog fuel boiler reduced the mill's purchases for electricity and coal, and the savings were realized directly. In other words, the waste treatment operation became part of the mill's utilities needed for production. Competitive evaluations of polymers from other suppliers demonstrated conclusively to this mill that savings achievable strictly on a cost-competitive basis would have amounted to no more than 10 to 15% based on the polymer costs alone. However, these savings would only have improved the costs of operation of this mill's wastewater treatment plant by 4 to 7% overall. It is claimed that by using NALCO Chemical Company as part of a service-intensive contract approach to the water treatment chemicals business, the customer actually achieved savings of 10.5%, while realizing a 16.5% net savings in polymer at the same time.
W85-05405

ANAEROBIC TREATMENT OF FUEL ALCOHOL WASTEWATER BY SUSPENDED GROWTH ACTIVATED SLUDGE,
Oklahoma State Univ., Stillwater. School of Civil Engineering.
E. L. Stover, G. Gomathinayagam, and R. Gonzalez.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 95-104, 9 Fig, 5 Tab, 8 Ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, Sludge, Fuel alcohol, Methane, Cattle feed, Kinetics, Sludge utilization.

Anaerobic treatment of high strength fuel alcohol production wastewater was examined for methane production and the suitability of the resultant sludge for cattle feed with both batch and continuous flow methods. Both the kinetics of substrate removal and the quality of methane production were a function of the food/microorganisms (F/M) ratio. The protein and carbohydrate content of the anaerobic biological sludge makes it suitable for use as cattle feed when dried and mixed with stillage solids. The reaction kinetics of the batch and continuous systems appear different due to volatile acid accumulations in the batch systems above a certain F/M ratio.
W85-05406

CHEMISTRY AND APPLICATION OF OZONE AND ULTRAVIOLET LIGHT FOR WATER REUSE: PILOT PLANT DEMONSTRATION,
Westgate Research Corp., West Los Angeles, CA.
J. D. Zeff, and J. A. Harris.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 105-116, 3 Fig, 6 Tab, 5 Ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, Pesticide removal, UV-ozonation treatment, Lime pretreatment, Hazardous materials, *Water reuse.

The objective of this study was to demonstrate on a small pilot plant of a typical industrial wastewater, the destruction of refractory and toxic organic residues by a UV-ozonation process. A standard Model P-602 (ULTROX) Pilot Plant was used. Lime pretreatment increased the efficiency of the UV-ozonation process. The ozone dose requirement is 4.1 mg O3/liter of effluent. An oxygen supply is more economical than air. The cost savings of this system compared to landfill disposal are significant and under certain conditions the payback of the equipment is less than seven months without including the value of the reusable water.
W85-05407

CASE HISTORIES: PRETREATMENT OF POULTRY PROCESSING WASTEWATER,
Georgia Dept. of Natural Resources, Atlanta. Environmental Protection Div.
K. Hopkins.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 117-131, 5 Fig, 17 Tab.

Descriptors: *Wastewater treatment, *Poultry wastes, Air flotation, Biological oxygen demand, Suspended solids, Biodegradation.

The pretreatment of wastewater at four poultry processing plants was examined. Raw and pretreated wastewater characteristics, the various treatment processes employed, chemicals used and the impact of this wastewater on the treatment plant were summarized. Poultry processing wastewater contains high organic matter, high suspended solids, floating materials, fat, oil, and grease; and is readily biodegradable. Poultry processing wastewater can be successfully treated by a dissolved air flotation system with the addition of coagulant and flocculant. Removal of BOD to 250 mg/liter TSS to 250 mg/liter, and oil and grease to < 100 mg/liter can be achieved. The pretreated poultry wastewater can then be readily treated by a biological process in a municipal wastewater treatment system.
W85-05408

TREATMENT OF BEEF SLAUGHTERING AND PROCESSING WASTEWATERS USING ROTATING BIOLOGICAL CONTACTORS,

Northeastern Univ., Boston, MA. Dept. of Civil Engineering.
F. C. Blanc, J. C. O'Shaughnessy, and S. H. Corr.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 133-140, 10 Fig, 1 Tab, 7 Ref.

Descriptors: *Wastewater treatment, *Slaughtering wastes, Biological treatment, Biological oxygen demand, Suspended solids, Aerobic treatment, Effluents, Kinetics, Waste load, Sludge.

A study was conducted to evaluate treatment kinetics, waste loading rates, removal efficiencies and sludge production rates associated with beef slaughtering wastewaters. The results indicate that rotating biological contactor units can be used to treat a combination beef slaughtering and process wastewater to achieve 65 to 70% BOD reduction. However: (1) severe foaming problems can arise; (2) further treatment will be required prior to discharge; (3) solids settling is poor; and (4) the volume-to-surface ratio of the reactor has little impact on treatment efficiencies. The expected salt concentration would have little, if any, effect on the treatment process. The study also indicates that anaerobic pretreatment could improve the treatability of the wastewaters. Aerobic treatment, without anaerobic pretreatment, would require extended aerobic polishing to obtain secondary treatment effluent standards.
W85-05409

INTEGRATING ANAEROBIC DIGESTION AND ALGAL-BIOMASS TREATMENT PROCESSES FOR SWINE WASTEWATER,
Hawaii Univ., Honolulu. Dept. of Agricultural Engineering.
P. Y. Yang, and S. Y. Nagano.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN. May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 141-161, 15 Fig, 11 Tab, 31 Ref.

Descriptors: *Wastewater treatment, *Swine wastewater, *Anaerobic digestion, Algal-biomass raceway, Methane production, Retention time, Hydraulic loading, Chemical oxygen demand, Sedimentation, Effluents, Biological oxygen demand, Oxidation ditches, Oxidation ponds.

A study was conducted to develop a set of full design and operational criteria for both anaerobic digestor and algal-biomass raceway treatment processes for swine wastewater in a tropical environment. Five different overall hydraulic retention times (HRT) and total volatile solids (TVS) loading rates were used to determine the critical loading rate for maximum gas production in the anaerobic digestion process. Maximum methane production is at approximately 3.0 g TVS/liter/day. The main objective of using an algal-biomass raceway system is to reduce the soluble COD and NH4-N concentration of anaerobically digested effluent by aerobic bacteria and microalgae. Care must be taken that overaeration does not decrease the pH and kill the algae. The raceway effluent after sedimentation can meet the IWDP standards for total BOD, suspended solids and NH4-N concentrations. The anaerobic digestor-algal-biomass system has some advantages over other systems. It has a much higher BOD loading rate compared to a faculative oxidation pond and it uses 1/10 the energy of an oxidation ditch. Selecting the proper option depends on the cost of land, energy and equipment.
W85-05410

PILOT PLANT TREATMENT OF SWINE WASTES BY THE DEEP SHAFT METHOD,
Tokyo Univ. of Agriculture (Japan). Dept. of Liberal Education.
K. Ishimaru, G. Oyama, A. Ushikubo, and F. M. D'Itri.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 163-71, 2 Fig, 4 Tab, 7 Ref.

Descriptors: *Wastewater treatment, *Swine wastewater, Deep shaft method, Biological oxygen demand, Chemical oxygen demand, Suspended solids, Nitrogen compounds, Activated sludge process, Organic loading, Retention time, Aeration, Ammonia.

The advantages of the deep shaft (tall cylinder) wastewater treatment method for swine wastes compared to the conventional activated sludge system are: much higher organic loading capacity, reduced retention time, and more efficient oxygen and energy utilization due to intimate contact between oxygen, substrate and organism. Because the system is compact, less land is required. Circulation velocities are directly related to the aeration depth, volume of pumped air, diameter of the user pipe, and water level in the shaft. Maximum oxygen dissolution efficiency was obtained at an aeration depth of 300 cm and a pumped air volume of 10 liter/min. Under these conditions, the maximum BOD loading rate was limited to 2.00 kg/cu m/day. At a loading rate of between 0.6 and 2.0 kg/cu m/day, the BOD, COD and suspended solids removal rates exceeded 85%, while the percent removal of ammonia and total Kjeldahl nitrogen ranged from 72 to 95%.
W85-05411

SINGLE STAGE NITRIFICATION ACTIVATED SLUDGE PILOT PLANT STUDY ON A BULK PHARMACEUTICAL MANUFACTURING WASTEWATER,
Merck and Co., Inc., Rahway, NJ.
R. T. Donahue.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 173-180, 1 Fig, 7 Tab, 6 Ref.

Descriptors: *Wastewater treatment, *Pharmaceutical wastes, Nitrification, Sludge drying, Sedimentation, Activated sludge process, Biological oxygen demand, Chlorination.

The pilot plant treatability data for sludge thickening and dewatering studies for a pharmaceutical manufacturing wastewater primarily during the first five month of operation are summarized. The plant consists of an equalization basin, neutralization, primary sedimentation, roughing biofilter and a single stage nitrification activated sludge system. The values of the BOD removal rate constant, K, determined for the pilot plant study did not demonstrate the expected relationship of between reaction rate and temperature. The pilot plant oxygen uptake rate data demonstrates a low net oxygen requirement for nitrification. The system operation was stable and efficient at F/M ratios of 0.19-0.30. A prolonged period of operation at an F/M ratio 0.15 led to an episode of filamentous bulking. Chlorination of the mixed liquor for eight days at dosages ranging from 3.0-7.5 lb. Cl2/1000 lb. MLVSS successfully controlled the bulking. Nitrification stopped during the chlorination period. At aeration basin temperatures > 38 C, BOD removal efficiency decreased and nitrification ceased. The oxygen uptake rate test was a good indicator of wastewater toxicity or inhibition of the microorganisms.
W85-05412

COMPARISON OF DOME AND STATIC AERATORS TREATING PHARMACEUTICAL WASTE,
Manhattan Coll., Bronx, NY. Dept. of Environmental Engineering and Science.
J. A. Mueller, R. T. Donahue, and R. Sullivan.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 181-192, 6 Fig, 6 Tab, 3 Ref.

Descriptors: *Wastewater treatment, *Pharmaceutical wastes, Oxygen diffusion, Aerators, Activated sludge process.

The design criteria for a new activated sludge system to replace an existing activated sludge system and rock biofilters for treating pharmaceutical wastes were defined. Kenics static aerators and Gray Fine/Air dome diffusers were evaluated. Excellent agreement was obtained between the calculated and measured oxygen saturation values for both dome and static aeration systems. This indicates the validity of KL a measurements obtained by the dual nonsteady state testing technique in a completely mixed aeration tank under process conditions. Process water results on both systems had a tendency for alpha and theta to vary with gas flow. Theta values in the range of 1.02-1.026 are representative of the design range for the dome systems and from 1.015 to 1.024 for the static aeration system. Theta values decrease with increasing gas flow. Alpha values for the static aeration system were somewhat higher than those in the dome aeration system varying from 0.64 to 0.75 in the design range versus 0.5 to 0.57 for the dome system. These values are specific for the high strength and high total dissolved solids Merck pharmaceutical wastewater. Efficiency of the dome diffuser system is the same as the static aeration system under process conditions at low air flows, and it increases as airflow increases. At the normal operating air flows, the dome diffuser system is 14% more efficient than the static aeration system. These results are specific for the Merck pharmaceutical wastewater.
W85-05413

TREATMENT OF WOOL SCOUR WASTEWATER: RECENT TRENDS IN NEW ZEALAND,
Canterbury Univ., Christchurch (New Zealand). Dept. of Civil Engineering.
F. Wilson, and P. H. King.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 193-200, 5 Fig, 9 Tab, 10 Ref.

Descriptors: *Wastewater treatment, *Wool scouring, *Textile mill wastes, Aerobic treatment, Anaerobic digestion, Solvent extraction, Pentanol, Chemical oxygen demand, Activated sludge process, Effluents.

Present trends in New Zealand indicate that the preliminary treatment stage incorporated in the Wronz mini bowl scouring system could provide a useful starting point in the overall treatment of wool scour wastes. Anaerobic digestion of a cracked jet liquor appears to be favored over aerobic processes which suffer from efficiency reductions in the cold New Zealand winter. Further experiments are being conducted both with variations of the anaerobic filter and with upward flow sludge blanket digesters. Meanwhile the DSIR pentanol extraction process has been patented and prototype trials have been run in Dunedin in the last year. The effluent has proven acceptable for direct treatment in the local authority biological treatment plant.
W85-05414

BIOLOGICAL TREATABILITY STUDY OF WASTEWATER FROM A NYLON FIBERS AND PLASTICS FACILITY,
Rivanna Water and Sewer Authority, Charlottesville, VA.
G. A. Anderson, G. D. Boardman, and D. A. Wallis.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 201-210, 7 Tab, 16 Ref.

Descriptors: *Wastewater treatment, *Nitrogen removal, *Activated sludge process, Caprolactam, Nylon, Plastics, Textile mill wastes, Organic carbon, Hydrogen ion concentrations, Temperature effects, Evaporation.

The feasibility of reducing nitrogen levels in wastewater containing about 10,000 mg/liter caprolactam from a nylon fibers and plastics manufacturing plant was investigated. Activated sludge is an effective means of treating textile wastewaters which contain high levels of caprolactam. Although problems with evaporation somewhat confound the calculations, it is believed that organic carbon and total Kjeldahl nitrogen removals of up to 95 and 80%, respectively, were obtained. Tem-

perature and pH were very important factors, and in no systems was nitrification apparent. In those reactors operated at sludge ages suitable for nitrification, it is believed that nitrification was inhibited by caprolactam, low dissolved oxygen levels, and/or high levels of ammonia.
W85-05415

STUDY ON REUSE OF WATER IN A WOOLEN MILL,
Tongji Univ., Shanghai (China). Dept. of Environmental Engineering.
H. Jiajun.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 211-219, 2 Fig, 5 Tab.

Descriptors: *Wastewater treatment, *Dye industry wastes, Water reuse, Color, Color removal, Cost analysis, Activated carbon, Effluents, Textile mill wastes, Coagulation, Adsorption.

This study reports the results of treating and/or recycling the wastewaters from dyestuffs which were either acidic mordant dyes, disperse dyes, sulfur dyes, neutral dyes, reactive dyes or direct dyes. After field experiments determined the design parameters, a biotower-flotation process was used. The effluent from this process has been meeting the criteria for discharge but has a distinct color that excludes the effluent from reuse. Subsequently a coagulation-adsorption process for decolorization was added so that the effluent could be recycled with insignificant modification of the existing facilities. This strategy makes it possible to refrain from discharge of colored wastewater and is economically feasible. The cost for reuse is 0.2 Yuan/cu m which includes the cost for wastewater treatment of 0.16 Yuan/cu m as opposed to the cost of tap water (0.12 Yuan/cu m). The key is the availability of waste activated carbon from a nearby pharmaceutical factory.
W85-05416

BIOLOGICAL TREATMENT OF CYANIDATION WASTEWATERS,
Homestake Mining Co., Lead, SD.
T. I. Mudder, and J. L. Whitlock.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 279-287, 1 Fig, 3 Tab, 5 Ref.

Descriptors: *Wastewater treatment, *Mine drainage, Cyanide, Thiocyanate, Gold, Silver, Ammonia, Nitrogen compounds, Construction costs, Operating costs, Biological treatment, Pilot plants, Toxic wastes.

Since 1977, personnel at Homestake Mining Company's Homestake Gold Mine in Lead, SD, have been engaged in research and development of a process to treat a maximum of 5.5 MGD (3600 gpm) of combined mine and tailings impoundment wastewaters containing free cyanide, complexed cyanides and thiocyanate. Various chemical and/or physical treatment processes were pilot plant tested, but construction of a full-size treatment based on these principles never materialized due to inadequate treatment performance, residual toxicological effects associated with the effluent, or prohibitive capital and/or operating costs. The bacterial seed was found in Homestake wastewaters. During the pilot plant evaluations the bacteria were gradually and specifically acclimated to the wastewater combination to be treated. The only chemical requirements were an inorganic carbon source to aid nitrification and phosphorus as a trace nutrient. The biological treatment processes removed thiocyanate, free and metal complexed cyanides, metals and ammonia through oxidation and adsorption. The products included the anions sulfate, nitrate and carbonate. The kinetics of thiocyanate, cyanide and ammonia oxidation were generally zero order down to levels of 1 mg/L for thiocyanate and cyanide, and 4-5 mg/L for ammonia.
W85-05417

ADAPTATION OF AN INDUSTRIAL ACTIVATED SLUDGE PROCESS TO THE REMOVAL OF CYANIDE,
Alabama Univ. in Birmingham. Dept. of Biology.
D. Harden, D. D. Jones, and J. J. Gauthier.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 289-298, 8 Fig, 6 Tab, 15 Ref.

Descriptors: *Wastewater treatment, *Cyanide, *Ammonia, Phenol, Thiocyanate, Biological treatment, Nitrification, Organic loading, Toxicity, Toxic wastes.

The object of this paper was to determine whether a mixed microbial population already adapted to the treatment of steam-stripped coke-plant wastewater could be further adapted to treat the higher concentrations of ammonia and cyanide found in non-distilled ammonia liquors. Treatment of relatively high concentrations of cyanide is possible at moderate organic loadings, after an extended period of adaptation. The nitrifiers did not appear to become significantly more tolerant to cyanide, but the action of cyanide degraders in a complex-mix process provided protection of the nitrifiers from the inhibitory effects of cyanide. Phenol and thiocyanate removal were unaffected by cyanide. The primary difficulty in treating high strength coke-plant wastewater appears to be the general toxicity that occurs at higher organic loadings which decreases the efficiency of all the microorganisms in the system.
W85-05418

MIXED CULTURE BIOLOGICAL ACTIVITY IN WATER CONTAINING VARIABLE LOW CONCENTRATIONS OF CYANIDE, PHENOL, AND BOD,
Yarmouk Univ., Irbid (Jordan). Dept. of Civil Engineering.
A. M. Shahlaham.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 311-322, 5 Fig, 5 Tab, 22 Ref.

Descriptors: *Wastewater treatment, *Phenol, *Cyanide, Temperature effects, Mathematical models, Statistics, Biological oxygen demand, Biodegradation, Toxic wastes.

The biological degradation rate of easily degradable carbonaceous materials in waters containing phenol and cyanide was determined. Two complete-mix, continuous, mixed culture reactors were used; one was run at 9 C and the other at 24 C. In addition to temperature, the concentrations of glucose, phenol, cyanide, nitrogen and other trace chemicals remained constant in a pair of simultaneous experiments. The experiments were intentionally performed at very low concentrations of glucose, phenol and cyanide. In a complex solution of various chemicals such as glucose, phenol, and cyanide, the degradation rate of one chemical is dependent on the presence of other chemicals. Without the definitive knowledge of the interrelationships of these chemicals while being degraded in waters by biological mass, the biodegradation rates may be expressed as functions of chemical concentrations and temperature utilizing statistical methods.
W85-05419

WET OXIDATION OF PACT PROCESS CARBON LOADED WITH TOXIC COMPOUNDS,
Zimpro, Inc., Rothschild, WI.
T. L. Randall.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 323-338, 4 Fig, 15 Tab, 13 Ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Chlorinated hydrocarbons, Hydrocarbons, PACT process, Wet air regeneration, Domestic wastes, Priority pollutants, Phenols, Organic loading, Organic compounds, Nitrogen compounds, Activated carbon, Toxic wastes.

The results of laboratory studies of the destruction of priority pollutants such as cyanides and phenols, during wet air regeneration are reported as are the results of continuous flow PACT/Wet Air Regeneration system studies to observe removal of toxic organics. In the case of 2-chlorophenol, destruction of more than 98.4% was observed. The residual 2-chlorophenol was tightly bound to the carbon with only traces of it appearing in the liquid phase. No formation of priority pollutants during regeneration was observed and only low molecular weight oxygenated species were identified. Pilot plant PACT treatment studies on wastewater containing chlorinated aromatic hydrocarbons demonstrated excellent removal by PACT (92-100% for most pollutants) and ultimate destruction of these compounds during wet air carbon regeneration. Additional continuous pilot studies employing the PACT system with wet air regeneration have shown reduction of wastewater toxicity, resistance of the treatment system to shock organic loads such as phenol, and excellent removal of priority pollutants.
W85-05420

MERCURY REMOVAL FROM A CHLORAL-KALI PLANT IN EGYPT,
Alexandria Univ. (Egypt). Higher Inst. of Public Health.
A. Hamza, O. Elsebai, and H. Saleh.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 339-347, 4 Fig, 4 Tab, 9 Ref.

Descriptors: *Wastewater treatment, *Mercury, *Electrolysis, Effluents, Rechlorination, Clay adsorption, Activated sludge process, Fish, Contamination, Mortality, Toxic wastes.

Wastewater containing the electrolysis effluent from the Misr Chemical Company has a high mercury concentration (17.3 mg/L). The treatment train used in this study consisted of pH adjustment, clay adsorption, and an activated sludge biological system. Aeration and dechlorination may achieve 50% reduction in the mercury content. A local clay has satisfactory adsorption capacity compared to activated carbon. Clay adsorption reduced mercury concentration to about 1 mg/l. Further reduction in mercury was attained by biosorption using 20 mg/l PAC and an average detention time of 24 hr. Spontaneous death was observed when fish inhabited raw electrolysis wastewater due to its high chlorine content. Fish living in sublethal dilutions of the pretreated effluent showed progressive mercury accumulation in the gills and liver while the flesh contained relatively low mercury levels.
W85-05421

TREATMENT OF CYANIDE-CONTAINING WASTEWATERS BY THE COPPER-CATALYZED SO2/AIR OXIDATION PROCESS,
Canviro Consultants Ltd., Kitchener (Ontario).
S. G. Nutt, and S. A. Zaidi.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 357-368, 3 Fig, 6 Tab, 18 Ref.

Descriptors: *Wastewater treatment, *Cyanide, *Gold, *Metal-finishing wastes, Operating costs, Capital costs, Oxidation process, Catalysts, Sulfur dioxide/air oxidation, Toxic wastes.

The results of laboratory scale treatability studies of the INCO copper-catalyzed sulfur dioxide (SO)/air process for the treatment of barren bleed solutions from several Canadian gold mills and rinsewaters from several metal plating operations containing cyanides are reviewed. Conceptual process design details for full-scale SO/air oxidation systems applicable to these wastewaters are presented and capital and operating cost estimates for the process are developed. In the presence of adequate concentrations of dissolved copper, and SO/air oxidation process was capable of reducing cyanide concentrations from > 1 g CN/L to < 1 mg CN/L. The optimum copper concentration

was dependent on the composition of the untreated sample. Removal efficiencies exceeding 99% in terms of cyanide species and heavy metabls were achievable during treatment of gold mill barren bleed solutions and metal finishing rinsewaters. Removal of > 99.5% of iron present as iron cyanide complexes was attained in the presence of adequate concentrations of copper and zinc in the wastewater sample. Thiocyanate was virtually unaffected. The estimated total annual cost associated with the operation of an SO/air oxidation process at a model gold mill are $1.77 to $2.07 per kg CN removed. Chemical costs amount to approx $0.98 per kg CN removed. The estimated total annual costs for copper cyanide rinsewater treatment are approximately $26,050, equivalent to $11.95 per kg CN removed. Chemical costs amount to approximately $4.31 per kg CN removed.
W85-05422

CATALYTIC OXIDATION OF MUNITIONS WASTEWATER,
Pima County Dept. of Wastewater Management, Tucson, AZ.
C.-J. Kuo, and R. A. Sierka.
In: Proceedings 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 377-385, 13 Fig, 2 Tab, 7 Ref.

Descriptors: *Wastewater treatment, *Ozonation, *Munitions wastewater, Organic compounds, Hydrogen ion concentration, Catalyts, Organic carbon.

The specific objectives of this study were as follows: (1) to quantify the effect of the Raney Nickel (Ra-Ni) Catalyst concentration on the kinetics of trinitrotoluene/cyclotrimethylenetrinitramine (TNT/RDX) destruction and (2) to quantify the effect of Ra-Ni concentration and initial solution pH on the rate and extent of TNT/RDX destruction when ozone is employed as the oxidant. For both the catalytic destruction process and the catalytic ozonation process; the initial rates of total organic carbon (TOC) and TNT destruction increased with increased concentrations of Ra-Ni. For experiments with the same concentration of Ra-Ni, the higher the ozone dose, the higher the rate of TOC destruction. However, the rate of TNT destruction was not improved, or it was adversely affected by the presence of ozone in the reactor. The rate of TOC destruction at the same ozone dose was enhanced when Ra-Ni was present in the reactor, especially at the high initial solution pH levels.
W85-05423

MICROBIAL RESPONSES TO ORGANIC SPECIES IN INDUSTRIAL LANDFILL LEACHATE,
Rutgers - The State Univ., Piscataway, NJ. Dept. of Chemical and Biochemical Engineering.
P. Corbo, and R. C. Ahler.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 387-393.

Descriptors: *Wastewater treatment, *Industrial waste, *Leachates, Activated sludge process, Landfills, Groundwater pollution, Runoff, Surface water, Organic carbon, Oil wastes, Lime.

The biological treatment of liquid residuals produced by water runoff due to rain, surface water and/or groundwater that has become contaminated as it passes from or through a landfill holding industrial wastes is described. Leachate used in this study was supplied by USEPA Oil and Hazardous Material Spill Branch. The bulk aqueous phase was separated from the bulk of oil phase by gravity separation and was further treated with lime at 6 gm/L. An activated sludge culture seed was obtained from the Somerset-Raritan Sewerage Authority. The leachate used in the study was not lethal to a mixed population of activated sludge organisms. Leachate organic components induced high respiratory activity that correlates with dissolved organic carbon (DOC) reductions. The organic species are available as a growth carbon source, and biodegradation does not require the presence of an easily degradable carbon source. An overall leachate DOC reduction of 80% (shake flask) and 65% (fermentor) have been observed. Absorption of DOC on cellular material did not appear to be taking place although a definite conclusion on this matter could not be drawn.
W85-05424

PILOT STUDY FOR THE REMOVAL OF PRIORITY POLLUTANTS BY THE PACT PROCESS,
Greeley and Hansen, Chicago, IL.
J. W. Cormack, D. Y. Hsu, and R. G. Simms.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 403-415, 4 Fig, 4 Tab, 17 Ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Activated sludge Process, Pollutants, Pretreatment of water, Organic compounds, Metals, Heavy metal, Trace metals, Cyanide, Inorganic compounds, Toxic wastes.

A pilot study of the PACT process for pretreatment of industrial waste discharged to the Kalamazoo treatment plant is reported. The PACT process apparently has higher tolerance limits for toxic substances than the activated sludge process. The treatment performance was not affected at the maximum concentrations used in running this pilot study. Among the 28 priority pollutants investigated were acrolein, phenol, tetrachloroethylene, toluene, arsenic, cadmium, cyanide, mercury. A large number of these pollutants as found in the raw wastewater in the Kalamazoo Wastewater Treatment Plant can be removed by the PACT process. The removal efficiency may range from > 54.2 to > 97.4% for the organic pollutants, and 9 to 82.9% for the inorganic pollutants.
W85-05425

REMOVAL OF METAL IONS FROM WASTEWATER BY ALGAE,
Clemson Univ., SC. Dept. of Environmental Systems Engineering.
F. J. Sloan, A. R. Abernathy, J. C. Jennett, and G. V. Goodman.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 423-429, 7 Fig, 2 Tab, 22 Ref.

Descriptors: *Wastewater treatment, *Cadmium, *Copper, *Lead, *Zinc, *Algae, Anabaena, Nostoc, Chlorella, Industrial wastewater.

Green algae and blue-green algae were tested for their ability to remove cadmium, copper, lead and zinc from solution. Approximately 50% of the ions were removed by the algae, although this was not reproducible with the zinc ion. Calculations for process design and algae mass for some industrial wastewater situations are given. The study confirms other reports that algae introduced to metals in solution are capable of removing them from solution.
W85-05426

COPPER RECOVERY FROM A BRASS BRIGHT DIPPING SOLUTION,
Modine Mfg. Co., Racine, WI.
J. C. Egide, and W. M. Robertson.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 431-438, 4 Fig, 4 Tab, 8 Ref.

Descriptors: *Wastewater treatment, *Copper, *Brass, Metal-finishing wastes, Operating costs, Economic evaluation.

An acid retardation system for the removal of copper metal and its subsequent recovery from a brass bright dipping solution has been developed and field proven by the Modine Manufacturing Company at its Trenton, Missouri facility. The system returns concentrated etchant chemicals back to the processing bath. Advantages of the system, in addition to the recovery of copper metal, include a reduction of overall cleaning line maintenance time, an improvement in process bath life, a reduction in wastewater treatment operations, and an overall stabilization of the cleaning line processes. The system has demonstrated a rapid payback and has readily justified the initial capital investment.
W85-05427

DISTRIBUTION OF CADMIUM AND NICKEL IN ACTIVATED SLUDGE SYSTEMS,
Illinois Inst. of Tech., Chicago. Dept. of Environmental Engineering.
P. S. Kodukula, and J. W. Patterson.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 439-448, 14 Fig, 29 Ref.

Descriptors: *Wastewater treatment, *Nickel, *Cadmium, *Hydrogen ion concentration, Activated sludge process, Adsorption, Suspended solids, Precipitation.

pH seems to be a master variable controlling adsorption of metals to activated sludge solids. Percent metal adsorption increased by > 70% over 1-2 units of pH change. In the case of cadmium, significant change in percent adsorption seems to occur between pH values of 5.0 and 7.0 whereas for nickel, the adsorption edge is shifted toward a higher pH with maximum change in percent removal being in the pH range of 6.0 to 8.0. At a pH of 8.0, removals of both cadmium and nickel were 90% while at pH 7.0 removal of cadmium remains about the same with that of nickel dropping down to 60%. For the highest removals to cadmium as well as nickel, a pH > 8.0 would be preferable. The effect of suspended solids on distribution of metals at a high pH (8.0) seems to be minimal but is quite significant at low pH. In the case of cadmium as well as nickel at a pH of above 8.0 is solid-bound metal was above 90%, irrespective of suspended solids concentrations tested. However, at pH levels below 7.0, influence of suspended solids on metal distribution is more pronounced. Thus a combination of low pH levels and low suspended solids concentrations yields adverse results when high removals of metals, particularly, nickel, are desired. The results of this study demonstrate that at the mixed liquor suspended solids concentrations and pH values, generally encountered in full-scale activated sludge plants, metals are removed primarily by sorption processes. Even at low pH levels, where adsorption diminishes, precipitation may not take place because of the simultaneous increase in the solubility limit of the system with a decrease of pH.
W85-05428

WASTEWATER TREATMENT FOR A SMALL CHROME PLATING SHOP: A CASE HISTORY,
J. G. Rabosky, and T. Altares.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 449-456, 2 Fig, 6 Tab.

Descriptors: *Wastewater treatment, *Metal-finishing wastes, Nickel, Copper, Heavy metals, Sludge, Chemical precipitation, Polyelectrolytes, Sulfuric acid.

A case history is presented of the design and operation of a wastewater treatment plant that dealt with the heavy metal, cyanide and phenol discharges from a small chrome plating shop. The raw wastewater was first analyzed and the flow-rate determined. Separate pits have been used to store the wastes from nickel/chrome vs copper plating operations separately; this procedure was maintained. For both wastewaters, sulfuric acid and polyelectrolyte were added, and the mix allowed to set for one hour. The metals precipitated after phase separation although the pH's were different in the two tanks. pH was then adjusted to 7.5-8.0 and the effluent was discharged. Sludge phases from both nickel/chrome and copper wastewater treatment were retained in a storage

tank for disposal by a contracted waste disposal service.
W85-05429

REMOVAL OF CHELATED NICKEL FROM WASTEWATERS,
Harza Engineering Co., Chicago, IL.
K. V. Mayenkar, and A. L. Lagvankar.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 457-472, 9 Fig, 8 Tab, 7 Ref.

Descriptors: *Wastewater treatment, *Nickel, Iron, Adsorption, Electric powerplants, Copper, Heavy metals.

The adsorption process was examined as a practical means of removing heavy metals, particularly nickel from boiler tube chemical cleaning wastewaters produced in steam-electric power plants. Bench scale studies of an iron filings treatment process, conclusions and recommendations are presented. For a give type of wastewater, dilution and filings/wastewater (F/W) ratio, quiescent and circulatory contact modes provided effective nickel removal. Wastewater filution considerably improved the rate of nickel removal for a given F/W ratio and contact mode. Higher ratios of iron filings contacted per unit volume of wastewater (F/W) removed larger amounts of nickel from the wastewater than for lower F/W ratios. The type of chelating agent present in the wastewater affects reaction rate. Higher wastewater temperatures may not improve the nickel removal rate. Under quiescent contact, an increase in bed surface area for a given F/W ratio improves the nickel removal rate. The overall metal removal rate in iron filings treatment are somewhat slow. However, the time of reaction should not rule out treatment by iron filings as a viable process for industries such as utilities where chemical cleaning wastewaters are generated only few times a year. This is especially true if the treatment results in a substantial cost savings.
W85-05430

TREATMENT OF ELECTROLESS COPPER PLATING WASTES,
New Hampshire Univ., Durham. Dept. of Civil Engineering.
P. L. Bishop, and R. A. Breton.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 437-480, 5 Fig, 7 Ref.

Descriptors: *Wastewater treatment, *Copper, *Metal-finishing wastes, Mathematical models, Electrolysis, Hydrogen ion concentration.

The performance of a specific high-surface area electrolysis system treating dilute, chelated copper rinsewaters from the printed circuit board industry was studied in terms of copper removal efficiency. The use of high-cathodic surface electrolysis technology can effectively remove copper from dilute, chelated rinse waters, with copper removal efficiency of 80 to 85%. Influent pH had relatively little effect on chelated copper removal over the pH range of 3 to 11. Influent copper concentration and flow rate (superficial velocity) exerted the strongest influences on unit performance. Removal efficiency was independent of influent copper concentration above 50 milligrams/l, but removal efficiency decreased significantly below this concentration. Flow rate (superficial velocity) proved to be the best predictor of unit performance. Recirculation of recovery unit effluent had no effect on overall treatment efficiency. A mathematical model was tested for its validity using experimental data and may be used to estimate certain design parameters for similar electrolytic devises treating chelated rinse waters.
W85-05431

BIODEGRADATION OF CHEMICAL PLANT WASTEWATER CONTAINING DIMETHYLFORMAMIDE,
Black and Veatch, Kansas City, MO.
J. L. Carter, and D. A. Young.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 481-486, 2 Fig, 4 Tab, 9 Ref.

Descriptors: *Wastewater treatment, *Chemical wastes, Dimethylformamide biological treatment, Organic compounds, Biodegradation.

The design of a biological system for the treatment of chemical plant wastewater containing dimethylformamide (DMF) is reported. The design and operation of this treatment plant were verified with a bench scale treatment plant. Operation at the design feed rate of 40 pounds DMF/day/1,000 cu ft was achieved with an effluent concentration of less than 10 mg/l for a three-month period. The pilot plant continues in operation, exploring different operating temperatures and feed rates. Effluent concentrations of less than 10 mg/l were achieved at feed rates as high as 90 pounds DMF/day/1,000 ct ft. Biological treatment of high strength DMF wastes has proven effective and practical.
W85-05432

CASE HISTORY: TREATMENT OF CHEMICAL PLANT WASTEWATER,
Weston Environmental Consultants-Designers, West Chester, PA.
R. Junkins.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 487-492, 4 Fig, 5 Tab.

Descriptors: *Wastewater treatment, *Chemical wastes, *Case studies, *Biological treatment, Biological oxygen demand, Chemical oxygen demand, Suspended solids, Pilot plants, Design criteria.

A case study concerning treatment of chemical plant wastewaters is presented. The raw wastewater was first analyzed and characterized. A biological approach to treatment was tested on a bench scale and the results used for the process design of a full scale plant. This biological approach has proven to be effective in operation as discharge limits for BOD, COD and suspended solids were consistently met or bettered. It is emphasized that due to the variability of chemical plant wastewater characteristics, treatability studies should be conducted on a case-by-case basis in order to identify and quantify the design parameters.
W85-05433

EVALUATION OF CHLOROFORM REMOVAL IN A BIOLOGICAL TREATMENT SYSTEM TO MEET BAT LIMITS,
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
Y. Argaman, and J. H. Koon.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 493-507, 5 Fig, 9 Tab, 8 Ref.

Descriptors: *Wastewater treatment, *Chloroform, Biological treatment, Aeration, Mathematical model, Costs, Activated sludge process, Activated carbon, Capital costs, Operating costs, Effluents.

The cost and effectiveness of eight treatment options for chloroform removal are summarized. The costs are only those which would be incurred in removing chloroform. The installation of subsurface aeration would result in the savings of $154,000/yr in energy costs. However, it is estimated that the difference in total annual cost for this option compared to use of surface aeration would be very small. Effluent chloroform concentrations would be significantly higher using subsurface aeration compared to using surface aeration. Calculated effluent concentrations obtained using the (1) PACT process or (2) an activated carbon approach are low, but the cost of implementing these options is very high, ranging from approx $4,440,000-$6,620,000. The incremental chloroform removed for these processes is very small compared to the relatively great cost for implementing these process alternatives. The calculated effluent chloroform concentrations for four others lay between 30 and 50 micro-g/l, while the cost of implementation ranged from $240,000/yr to $1,130,000/yr.
W85-05434

EDS COAL LIQUEFACTION WASTEWATERS: ZERO-DISCHARGE TREATABILITY STUDIES,
Exxon Research and Engineering Co., Florham Park, NJ.
S. A. Kaczmarek, and F. L. Robertaccio.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 509-517, 5 Fig, 4 Tab, 4 Ref.

Descriptors: *Wastewater treatment, *Coal liquefaction, Biological treatment, Activated carbon, Activated sludge process, Cooling towers, Water reuse, Organic carbon, Organic acids, Phenols, Ammonia, Dissolved solids.

Research to verify the commercial readiness of a zero-discharge treatment scheme for wastewaters produced by the EDS coal liquefaction process is discussed. Each separate process selected for the treatment of EDS wastewater has been demonstrated. The overall process scheme is capable of removing the wastewater constituents that could jeopardize the water's use in cooling tower. The coal liquefaction process waters tested would normally be diluted by other less concentrated and historically-treatable wastewater streams onsite, allowing even more confidence in assuring proper functioning of each of the treatment steps. For example, ammonia is controlled by stripping, biological treatment and cation exchange. In a full-scale operation, a stripper could target its ammonia removal to a level consistent with the nutrient needs of biological treatment. This study demonstrated several advantages to using carbon in Powdered Activated Carbon Treatment (PACT) rather than relying solely on Granular Activated Carbon adsorption. The PACT effluent of this study had similar characteristics to the GAC discharge after 150 turnovers, and achieved that with more economical use of the activated carbon (ie, more total organic carbon removed per mass of activated carbon). Assuming that ammonia and acid gas stripping, plus solvent extraction of phenolic compounds, were prerequisites for successful wastewater treatment, organic acids appear to have the greatest impact on overall treatment train design. They affect sizing of organic carbon removal facilities (biological treatment and carbon adsorption), the ability of strippers to remove ammonia, and the dissolved solids content of the post-stripped waters. Thus, future data on EDS-like wastes should try to quantify the organic acid component more adequately if an overly conservative treatment train design is to be avoided.
W85-05435

BIOLOGICAL TREATABILITY OF UNDERGROUND COAL GASIFICATION WASTEWATER,
Texas Univ. at Austin. Dept. of Civil Engineering.
T. P. Caire, D. F. Lawler, and M. J. Humenick.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 519-527, 8 Fig, 2 Tab, 12 Ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Coal gasification, Biological treatment, Kinetics, Chemical oxygen demand, Ammonia, Thiocyanate, Nitrogen compounds, Sulfur compounds, Phenols, Organic compounds, Suspended solids.

Wastewaters generated by an underground gasification process in Hanna, Wyoming were studied to (1) evaluate the kinetic coefficients; (2) determine the removal efficiency of selected wastewater contaminants and (3) observe the dependence of removal efficiency on sludge age. The wastewater had to be diluted to 10% strength due to inhibitory chemicals; 10 mg/liter of phosphorous was added to the diluted wastewater for optimum efficiency.

COD removals of 90% were obtained. The best estimates of the yield (Y) and decay (Kd) coefficient values associated with activated sludge treatment of this wastewater at 10% strength are 0.35 mg VSS produced/mg COD removed and 0.075/day, resp. Simple phenolic compounds, which comprise 70% of the COD of this wastewater, are almost completely removed during biological treatment. Thiocyanate and ammonia also can be oxidized by this process.
W85-05436

BIOTOXICITY OF COAL LIQUEFACTION WASTE IN THE ACTIVATED SLUDGE PROCESS,
Louisville Univ., KY. Dept. of Chemical and Environmental Engineering.
K.-C. Tsai, M. Fleischman, N. S. Yee, and J. H. Gray.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 529-539, 4 Fig, 5 Tab, 3 Ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Coal liquefaction, Biological treatment, Ammonia, Nitrogen compounds, Air stripping, Phenols, Sulfides, Chemical oxygen demand, Biological oxygen demand, Suspended solids, Hydrogen sulfide, Nitrification, Retention time, Aeration, Organic loading, Shock loads, Sludge volume index, Settling velocity, Effluents, Turbidity, Biomass.

It is possible to remove high levels of ammonia nitrogen from coal liquefaction wastewater by the activated sludge process with simultaneous high sulfide removal by air stripping. The factors to encourage nitrification include low ammonia loading (0.0106 g NH3-N/g MLSS/day), long hydraulic detention time (5 days), low organic loadings (0.163 g COD/g MLSS/day), long solids retention time (> than 60 days), gradual acclimation, and avoidance of shock ammonia loading. Ammonia nitrogen levels < 345 mg/l in the influent coal liquefaction wastewater or 0.0106 g NH3-N/g MLSS/day loading consistently produced effluent concentrations < 7.5 mg/liter. Above this influent concentration, the reactor's ammonia removal performance becomes unstable. Sulfides are removed from wastewater primarily by air stripping action in the aeration tank which has a pH of about 7. Air stripping of sulfide is highly efficient (> 99%) and its performance is independent of organic or ammonia loading to the tank. However, since H2S is released to the air, human exposure to the gas may pose a health risk. Chemical oxygen demand (COD) removal by the system was unaffected by changes in influent ammonia concentrations. Although BOD and phenol removals are susceptible to shock loading of ammonia nitrogen than is COD removal. Biotoxicity in the activated sludge reactor did not occur at phenol concentration as high as 1,800 mg/liter and phenol loading as high as 0.13 g phenol/g MLSS/day. The sludge settleability as measured by zone settling velocity (ZSV) and sludge volume index (SVI) improved during the six months of this study. Turbidity in the effluent increased as the levels of ammonia and sulfide in the influent increased. When the organic loading to the tank was doubled, the corresponding COD and BOD levels in the effluent also doubled. The biomass production declined significantly as the organic loading was doubled.
W85-05437

USE OF THE DOUBLE ALKALI FLUE GAS DESULFURIZATION PROCESS TO TREAT ELECTRIC UTILITY METAL CLEANING WASTES,
Donohue and Associates, Inc., Sheboygan, WI.
M. Crosser, and S. LaViolette.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 541-551, 13 Fig, 5 Tab, 3 Ref.

Descriptors: *Wastewater treatment, *Power plants, *Flue gas resulfurization, Bromate, Metals, Cadmium, Lead, Filter Cake, Boiler water, Arsenic, Organic compounds, Lime, Filtration, Land disposal, Arsenic, Chromium, Copper, Selenium.

The use of the flue gas desulfurization (FGD) process to treat wastewaters produced by removing scale from the boiler tubes and air heater of the Newton power station is reported. Ammoniated EDTA and ammoniacal bromate were chosen as the test cleaning solution as these are commonly used and are most difficult to treat by conventional methods. Ammoniated EDTA boiler cleaning wastewater cannot be used for slaking lime both because the EDTA solubilizes a substantial amount of calcium and because the slaking reaction is inhibited. Because ammoniacal bromate could potentially oxidize sulfite to sulfate and adversely effect the FGD buffer system, the slaking lime option was dropped. Washing filter cake with ammoniated EDTA or ammonia bromate is suitable at wash ratios of < 0.5 gm spent solution per gram cake moisture. As, Cd, Ba, Cr, Ag, Cu, Pb or Se are not increased in the filtrate returned to the process loop. Cake strength is maintained and the cake is not hazardous as defined by the RCFA. The metals in the cake can be isolated from the environment by proper landfilling. Disposal vs treating costs are compared.
W85-05438

UPGRADING THE PERFORMANCE OF A BLAST FURNACE SCRUBBER WATER CLARIFIER BY COAGULATION/FLOCCULATION OPTIMIZATION,
Dofasco, Inc., Hamilton (Ontario).
A. J. Palmer, and D. W. Averill.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 553-560, 4 Fig, 3 Tab, 5 Ref.

Descriptors: *Wastewater treatment, *Steel industry, *Flocculation, Suspended solids, Bench scale modelling, Optimization, Scale-up techniques, Clarifiers, Clarification, Model studies, Effluents.

Bench-scale modelling procedures, process optimization methodology and scale-up techniques in general are reviewed. The application of these techniques to solve the full-scale problem of the removal of particulates from a blast furnace scrubber water is outlined. Bench-scale optimization, using response surface methodology, was an effective technique for the improvement of process performance. An approximate comparison between a bench-scale model and full-scale hydraulic conditions resulted in a successful modification of the full-scale apparatus. In this case the lack of complete similarity between the two scales did not prevent attainment of the project goals. Inefficient flocculation was determined to be a major problem in the blast furnace clarifier system. This blast furnace clarifier is capable of providing an effluent containing a net suspended solids concentration of < 15 mg/liter. The process modification that increased flocculation substantially was successful in significantly reducing random and seasonal variation in clarifier performance.
W85-05439

BIOLOGICAL TREATMENT OF HIGH-STRENGTH COKE-PLANT WASTEWATER,
Alabama Univ. in Birmingham. Dept. of Biology.
D. D. Jones, J. L. Speake, J. White, and J. J. Gauthier.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 561-570, 13 Fig, 1 Tab, 10 Ref.

Descriptors: *Wastewater treatment, *Biological treatment, *Coke-plant wastewater, Ammonia, Organic carbon, Nitrification, Bacteria, Activated sludge process, Retention time, Effluent, Toxicity, Sludge volume index.

The objective of this project was to determine if a microbial population that had already been adapted to ammonia stripped coke-plant wastewater could be further acclimated to treat higher levels of ammonia and organic loading. Treatment of ammonia liquor (influent to the still) appears to be limited to a total organic carbon (TOC) of not more than 400 mg/liter at a hydraulic retention time of 42 hr. It is not clear whether the limitation is the inability of the microbes to degrade specific components of the influent load, thus increasing the toxicity, or the indirect consequence of filamentous growth that interferes with normal treatment plant operation. The increase in effluent TOC may have two different adverse effects: It may result in inhibition of the nitrifying bacteria, and it may create a selective environment for filamentous bacteria which may be less sensitive to the increased toxicity. It is concluded that high influent loadings of coke-plant wastewater may lead to the development of filamentous growth. Once established, such treatments as alkaline pHm exposure to hydrogen peroxide, and wasting at 4% or greater do not reduce the filament population. Operating at elevated temperature (42 C), effectively reduces the filamentous growth and improves settleability while maintaining good effluent quality. However, the long-term effects of operating at this temperature have not been determined.
W85-05440

CHEMICAL REACTOR DESIGN THEORY AND BIOLOGICAL TREATMENT OF INDUSTRIAL WASTES: IS THERE A GAP,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
A. W. Busch.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 571-577, 6 Fig, 21 Ref.

Descriptors: *Wastewater treatment, *Mathematical models, *Activated sludge process, Chemical reactions, Design criteria, Kinetics, Biomass, Biological treatment, Sedimentation.

Issues arising from the application of chemical reactor design theory for first order reactions to aerobic biological waste water treatment are addressed. The Monod kinetic model and/or its first order approximation are convenient descriptions of experimental data. However 'constants' of Ks and Um are highly system specific and thus are coefficients. Use of chemical reactor design theory for 'first-order' reactions is mathematically encouraged by the 'linear' relationship of the Monod model and/or its first order approximation. Biological continuous, stirred tank reactors (CSTRs) have the capacity to operate at the same overall average specific reaction rate as plug flow reactors (PFRs) and batch reactors (BRs). This can be shown conveniently by operating the CSTR at lower MSS concentrations. Thus, there is a 'gap' between chemical reactor design theory and biological waste water treatment. Maximum substrate removal rate cannot exceed loading rate. That is, loading rate is the limit on removal rate until maximum removal rates are achieved. Thus, an underloaded CSTR fulfills chemical reactor design theory by operating at a lower removal rate (read loading rate) than a batch or plug flow reactor. Reports of problems with settling properties of CSTR biomass are likely due to an underloaded process; i.e., too high MLSS. Biological CSTRs designed by chemical reactor therapy will have a greater treatment capacity than anticipated if oxygen transfer, nutrients, and final clarifiers are not limiting. Owners of treatment systems designed by chemical reactor theory are unlikely to complain if they find a higher capacity than anticipated and paid for. A rational basis for determining reactor performance is the Effluent Refractory Assessment test.
W85-05441

PILOT SCALE INVESTIGATIONS ON THE REMOVAL OF VOLATILE ORGANICS AND PHTHALATES FROM ELECTRONICS MANUFACTURING WASTEWATER,
Camp, Dresser and McKee, Inc., Boston, MA.
K. F. Whittaker, and A. T. Moore.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 579-589, 12 Fig, 7 Tab, 3 Ref.

Descriptors: *Wastewater treatment, Industrial wastewater, Activated carbon, Air stripping,

Methylene chloride, Electronic equipment, Organic compounds, Phthalates, Adsorption, Economic aspects, Operating costs.

The capability of powdered activated carbon to remove toxic organic compounds from electronic component manufacturing wastewater was examined. Activated carbon is not well suited for the removal of methylene chloride from wastewater. Carbon's low adsorption capacity, and therefore, the need for its frequent replacement to prevent compound desorption suggest that alternate means of treatment, such as air-stripping, would be far more suitable. Removal of other volatile organic compounds with activated carbon may be feasible due to demonstrably higher isotherm capacities. Since carbon requirements for full-scale column treatment are predictable from isotherm data, adsorbent requirements (and therefore approximate operating costs) should be predictable once influent concentrations and isotherm relationships are known. In treating electronic manufacturing wastewater, careful consideration should be given to the economic benefits of using a combination of air-stripping and activated carbon. Whereas the combined unit operations are effective in removing volatile organics, activated carbon alone will be successful in removing phthalate compounds. The high affinity of activated carbon for phthalates suggests that the concentration of these chemicals will not be a critical parameter in determining effective carbon adsorption life.
W85-05442

BATCH ADSORPTION OF ORGANIC POLLUTANTS FROM OXIDATION POND EFFLUENTS USING FLY ASHES,
Cleveland State Univ., OH. Dept. of Civil Engineering.
Y.-T. Hung.
International Journal of Environmental Studies, Vol. 21, No. 3/4, p 261-270, October, 1983. 4 Fig, 6 Tab, 5 Ref.

Descriptors: *Wastewater treatment, *Fly ash, *Adsorption, *Organic compounds, Oxidation ponds, Tertiary wastewater treatment, Volcanic ash.

The use of fly ash was evaluated in the tertiary treatment of wastewater to improve the oxidation pond effluent quality and to determine factors affecting the organic pollutant removal efficiency. The adsorbents selected for this study were three fly ashes obtained from power plants in North Dakota. A volcanic ash was also used for comparative purposes. Factors affecting organic removal efficiencies for oxidation pond effluent by fly and volcanic ashes were ash dosages, ash sizes, initial COD concentrations, and pretreatment condition of ashes. An increase in fly ash concentration caused a continual increase in organic removal efficiency until a fly ash concentration of 1000-2000 mg/l was attained, after which the removal efficiency remained fairly constant. The total organic carbon (TOC) removal efficiency varied from 30% to 58% at an ash concentration of 6000 mg/l. A decrease in fly ash sizes resulted in an increase in organic removal efficiency. A higher organic removal efficiency was observed at a lower initial pond effluent organic concentration. Washing of ashes by distilled water generally reduced the organic removal efficiency. Among the four ashes tested, volcanic ash D exhibited highest adsorption capacity due to its large surface area of 13,894 sq cm/cu cm. (Baker-IVI)
W85-05445

GROWTH STUDIES OF AZOLLA PINNATA RBR. IN A PERMANENT POND,
Indian Inst. of Tech., New Delhi. Centre for Rural Development and Appropriate Technology.
T. S. Kumar, P. Vasudevan, and S. V. Patwardhan.
International Journal of Environmental Studies, Vol. 21, No. 3/4, p 297-300, October, 1983. 1 Fig, 1 Tab, 7 Ref.

Descriptors: *Biological wastewater treatment, *Aquatic plants, *Biomass, Plant growth, Seasonal variation, India, Ponds.

Azolla growth was studied in a permanent pond in a village in India. The increase in biomass was determined every week by sampling Azolla pinnata from 20 x 20 cm quadrants from the pond. Depending on the season the samples consisted of mixed populations of Spirodela polyrhiza (duckweed) and A. pinnata. Over almost the entire year the water surface is covered with these two plants except when there is a shift from Azolla to to Spirodela. Growth is typically sigmoidal in nature. On the basis of weekly observations and the increment in terms of biomass, the doubling time is found to vary from 5.5 days to 13.5 days. Doubling time is lowest in October and November and increases with time. The observations indicate the suitability for integration of Azolla into various wastewater treatment systems. (Baker-IVI)
W85-05447

REMOVAL OF PHENOL USING WATER HYACINTH IN A CONTINUOUS UNIT,
Excel Industries Ltd., Bombay (India).
S. Vaidyanathan, K. M. Kavadia, M. G. Rao, S. Basu, and S. P. Mahajan.
International Journal of Environmental Studies, Vol. 21, No. 2, p 183-191, August, 1983. 3 Fig, 3 Tab, 17 Ref.

Descriptors: *Biological wastewater treatment, *Phenols, *Water hyacinth, Cost analysis, Industrial wastes, Wastewater treatment.

Experimental runs were performed on a continuous unit in an attempt to apply water hyacinth as a low cost treatment system for phenol removal from industrial wastewaters. Phenol in concentrations of 25, 75, 100, and 125 mg/l were added to an overhead tank, hyacinth and control tank. Detention times of 24 and 36 hrs were kept and flow rate adjusted knowing that the volume of hyacinth tank was 62 liters. The removal efficiencies were correlated with influencing parameters such as water hyacinth concentration, organic loading and hydraulic loading. The correlation offered a simple tool for the optional design of a water hyacinth system for phenol on an industrial scale. (Baker-IVI)
W85-05449

POLLUTING SEWERS BROUGHT UNDER CONTROL,
Marion County Health Dept., Indianapolis, IN. Bureau of Environmental Health.
For primary bibliographic entry see Field 5G.
W85-05470

WINTER WATER AND WASTEWATER OPERATIONS,
G. W. Szelc.
Public Works, Vol. 115, No. 8, p 62-64, August, 1984. 1 Fig.

Descriptors: *Water treatment facilities, *Wastewater facilities, *Cold weather operation, Ice formation, Water treatment, Settling basins, Freezing, Wastewater treatment, Intakes, Pipelines, Trickling filters.

A limited survey of select northern US water and wastewater facilities was made to examine winter problems and solutions. Some of the techniques will be of value to other operators and may be of particular help to those operating new treatment plants that have not yet gone through a winter season. A variety of problems surfaced with water treatment facilities. Freezing pipelines and ice formation in the various treatment basins were troublesome as were outdoor chemical feeding systems. Surface water intakes were plagued with ice formation and ice crystals blocking the intake screens. Ice formed around the drive columns of a circular sludge collector in an open settling basin. Ice movement in the settling basins caused some damage to concrete effluent flumes. Treatment equipment and processes for wastewater also face problems with winter cold and snow. Freezing pipelines, ice, problems with snow removal, a slow down in biological activity, and other factors all combined to tax the efforts of most operators. Trickling filters lost some of their efficiency in the colder climes and activated sludge might be the better choice. (Baker-IVI)
W85-05481

PRIMARY EFFLUENT FILTRATION. THE WARMINSTER EXPERIENCE,
Warminster Municipal Authority Wastewater Treatment Plant, PA.
S. Becker, and G. A. Garzonetti.
Public Works, Vol. 116, No. 2, p 54-56, February, 1985. 4 Fig.

Descriptors: *Wastewater treatment, *Primary effluent filtration, *Warminster, *Pennsylvania, Filtration, Trickling filters, Sand filters, Cost effectiveness.

Warminster is investigating a sand filter/trickling filter/sand filter scheme to increase plant capacity from the present 3 mgd to 7 mgd. The filtration of primary effluents has not been successful in the past because of high solids and grease content. With conventional filtration techniques, solids and grease clog the filter surfaces, resulting in very short filter runs and frequent backwashing. A cost effectiveness study indicated that expanding a trickling filter plant from 10 mgd to 20 mgd would be less expensive through increased trickling filters. Primary effluent filtration (PEF) and trickling filters were also shown to represent 15-20% less in operating costs than a conventional activated sludge system. Several benefits occur as a result of filtering primary clarified effluent ahead of secondary treatment. PEF allows the use of low cost trickling filters for secondary treatment instead of energy- and capital-intensive biological treatment with aeration. No matter which type of secondary treatment is used, PEF can allow significant plant expansions. Because waste activated sluge processes can be eliminated or avoided through the use of PEF, sludge handling costs can be significantly reduced. PEF substantially reduced humus generated in tricklng filters. The decrease in humus and increase in primary type solids improved the quality of digester supernatant, reducing its treatment needs. (Baker-IVI)
W85-05487

CROSSFLOW MEMBRANE TECHNOLOGY AND ITS APPLICATIONS,
Osmonics, Inc., Hopkins, MN.
D. J. Paulson, R. L. Wilson, and D. D. Spatz.
Food Technology, Vol. 38, No. 12, p 77-111, December, 1984. 13 Fig, 1 Tab, 21 Ref.

Descriptors: *Wastewater treatment, *Food processing wastes, *Filtration, *Membrane processes, Industrial wastes, Ultrafiltration, Microfiltration, Reverse osmosis.

Reverse osmosis, ultrafiltration (UF), microfiltration (MF), and particulate filtration are discussed with primary emphasis on the use of membranes in crossflow filtration. Crossflow membrane filtration is fundamentally different in design from other systems in that the influent stream is separated into two effluent streams, known as permeate and concentrate. The permeate is that fraction which has passed through the semipermeable membrane. The concentrate is that stream which has been enriched with the solutes of suspended solids which have not passed through the membrane. The membrane media is continuously self cleaned with solutes and solids swept away by the concentrate stream which is running parallel to the membrane. Required membrane characteristics are considered including pressure resistance, temperature resistance, pH resistance, and chemical compatibility. Membrane configuration for MF and UF are considered including tubular elements, hollow-fiber or capillary fiber, plate and frame element, and spiral wound element. Membrane configurations considered for RO include tubular, hollow fiber, plate and frame, and spiral wound. Crossflow filtration applications include desalination, and treatment of a variety of food processing waste streams. (Baker-IVI)
W85-05506

METABOLITES AND BIODEGRADATION PATHWAYS OF FATTY ALCOHOL ETHOXYLATES IN MICROBIAL BIOCENOSES OF SEWAGE TREATMENT PLANTS,
Henkel K.G.a.A., Duesseldorf (Germany, F.R.). Dept. of Ecology.
J. Steber, and P. Wierich.
Applied and Environmental Microbiology, Vol. 49, No. 3, p 530-537, March, 1985. 5 Fig, 5 Tab, 38 Ref.

Descriptors: *Wastewater treatment, *Biodegradation, *Fatty alcohol ethoxylates, Metabolites, Polyethylene glycol, Model studies, Isotopic tracers, Bacteria.

The characterization and identification of radiolabeled metabolites isolated from the effluent of a model sewage treatment plant are described. There is a faster degradation of the alkyl than the polyethylene glycol moiety and there are two distinct primary degradation mechanisms acting simultaneously in microbial biocenoses: intramolecular scission of the surfactant as well as oxidations of the alkyl chain. Characterization of the bulk of C-14 labeled metabolites as a homologous series of neutral and acidic polyglycol units and identification of several C2-fragments accounted for the depolymerization of the hydrophilic part of the surfactant by stepwise cleavage of ether-bound ethoxylate (EO) units. Hydrolytic as well as oxidative cleavage of C2-units is involved from additional degradation studies employing either neutral or carboxylated C-14 labeled polyethylene glycols as model metabolites. Most of the identified low-molecular-weight C-14 labeled acids suggest an ultimate degradation of EO monomers by the oxidative dicarbonic acid cycle or the glycerate pathways or both. In addition, the finding of considerable amounts of oxalic and formic acids allow consideration of an additional, mineralization route via glyoxylic, oxalic, and formic acids. The simultaneous action of different degradation mechanisms indicates the involvement of several distinct bacterial groups in the biodegradation of fatty alcohol ethoxylates under environmental conditions. (Baker-IVI)
W85-05510

EFFECT OF SEEDING DURING THERMOPHILIC COMPOSTING OF SEWAGE SLUDGE,
Tokyo Inst. of Tech. (Japan). Research Lab. of Resources Utilization.
K. Nakasaki, M. Sasaki, M. Shoda, and H. Kubota.
Applied and Environmental Microbiology, Vol. 49, No. 3, p 724-726, March, 1985. 2 Fig, 1 Tab, 7 Ref.

Descriptors: *Sludge composting, *Inoculation, *Wastewater treatment, Thermophilic composting, Biological treatment, Carbon dioxide, Composting, Thermophilic bacteria, Bacteria.

The effect of seeding on the thermophilic composting of sewage sludge was examined by measuring the changes in carbon dioxide revolution rates and microbial numbers. The starting materials for composting were prepared by mixing gamma-irradiated compost product or nonirradiated compost product as the seed with the raw sludge but at different ratios to retain similar physical and chemical properties. From the results it can be deduced that the rate of composting of sewage sludge is mainly controlled by the degradability of solid substrates and not by the kinds of microorganisms inhabiting the compost. The seeding of compost products at the start of sewage sludge composting, therefore, is unlikely to have any appreciable effects on the rate of composting or on the quality of the final product, although the degree of the contribution of thermophilic bacteria and thermophilic actinomycetes to the carbon dioxide evolution rate depends heavily on the amount of seed added. (Baker-IVI)
W85-05513

ASPECTS OF WATER AND SEWAGE TREATMENT IN AUSTRALIA,
Gutteridge, Haskins and Davey, Melbourne (Australia).
For primary bibliographic entry see Field 5F.
W85-05514

STABILITY AND SETTLING OF SUSPENDED SOLIDS IN SETTLING PONDS. PART II. DIFFUSION ANALYSIS OF INITIAL SETTLING OF SUSPENDED SOLIDS,
McGill Univ., Montreal (Quebec). Geotechnical Research Centre.
For primary bibliographic entry see Field 2J.
W85-05527

TEMPERATURE AND NUTRIENT EFFECTS ON THE ANAEROBIC EXPANDED BED TREATING A HIGH STRENGTH WASTE,
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
C. R. Kelly, and M. S. Switzenbaum.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 591-601, 4 Fig, 4 Tab, 27 Ref.

Descriptors: *Wastewater treatment, *Temperature effects, *Nutrient requirements, Anaerobic digestion, Micronutrients, Iron, Cobalt, Nickel, Activated sludge process, Chemical oxygen demand, Effluents, Suspended solids.

The purpose of this study was to define accurately the effects of temperature and nutrients on the anaerobic film expanded bed (AFEB) process treating a high strength waste. The AFEB process is relatively temperature insensitive. Calculated activation energies were low and within a narrow range (1875-3099 cal/mole). These values are much lower than those reported for anaerobic slurry systems. Likewise, calculated Q10 values were low (1.11-1.19) and indicate that the AFEB process is even more temperature tolerant than the activated sludge process. The AFEB process is more restricted by diffusional limitations than by biochemical reaction rates. Q10 values were on the order of 1.2 which is even less than typical values reported for diffusion limited systems. The addition of iron, cobalt, and nickel greatly enhanced reactor performance. COD removal rates increased and volatile organic acids (VOA) dramatically decreased after addition of the above elements to the influent substrate. The higher COD removal rates and the lower levels of VOA indicate that the methanogenic bacteria were more affected by nutrient-limitation than were the non-methanogenic bacteria. Micronutrients must not be overlooked and may not be a critical requirement for some industrial waste treatment applications.
W85-05547

DETERMINATION OF ALKALINITY REQUIREMENTS FOR THE ANAEROBIC TREATMENT PROCESS,
Dorr-Oliver, Inc., Stamford, CT.
A. Li, and P. M. Sutton.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 603-613, 4 Fig, 17 Tab, 18 Ref.

Descriptors: *Wastewater treatment, *Mathematical models, *Anaerobic, Bases, Digestion, Carbon dioxide, Volatile acids, Alkalinity, Hydrogen ion concentration, Bicarbonates, Pilot plants.

The purpose of this paper is to present a rational method for estimating the alkalinity requirements in the anaerobic wastewater treatment process. The demand for alkalinity is mainly for maintaining the CO2 equilibrium and for neutralizing the volatile acids. The calculation procedures are given and can be simplified by the construction of a PC02-BA-VA-PH diagram. A pilot plant demonstrated the usefulness of the model. A short discussion is included on the merits and disadvantages of some neutralizing compounds, such as NH3 and bicarbonate.
W85-05548

EFFECT OF INFLUENT CONCENTRATION ON THE STARTUP OF AN ANAEROBIC DOWNFLOW STATIONARY FIXED FILM (DSFF) REACTORS,
Ottawa Univ. (Ontario). Dept. of Civil Engineering.
K. J. Kennedy, and R. L. Droste.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 615-626, 12 Fig, 7 Tab, 12 Ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, Chemical oxygen demand, Load distribution, Volatile acids, Biomass, Influent streams.

This study reports the effects of (1) two support materials (needle punched polyester material and red draintile clay); (2) support surface area to volume rate; and (3) influent substrate concentration on biofilm accumulation and reactor startup. The effective performance of the polyester and the draintile appeared to be a function of the ease with which bacteria become attached. Leaching of minerals out of the clay may be a factor. Needle punched polyester has the advantage of light weight and versatility. Red draintile clay, on the other hand, is almost universally available and cheap. Increased surface area to volume ratios resulted in increased space loading rates and COD removal. Startup of reactors with higher surface area to volume ratios required a longer period of time which appeared to be related to the higher dependence these reactors and on methanogenic biofilm accumulation. Total biomass and biofilm yields were higher and rates of biofilm accumulation faster for treatment of lower strength wastes. The biofilms that were developed had similar specific activities. This would indicate for biofilms up to 1.8 mm in thickness that diffusional resistances in the biofilm were minimal. It appears advantageous to start reactors with a weak waste that would result in greater biofilm accumulation and easier operational control. The study has also shown that space loads can be increased in DSFF reactors while volatile acid levels are maintained between 200-1500 mg/liter. This assumes that the wastes are well buffered and pH is maintained in an optimum range (above pH 6.8). These results differ from those reported for startup of sludge blanket reactors. For these reactors it is reported that volatile acid levels should be negligible before implementing increases in space loads.
W85-05549

DESIGN AND PERFORMANCE OF EGG-SHAPED DIGESTERS FOR COMBINED SLUDGE AND INDUSTRIAL WASTEWATER TREATMENT,
Schulze (Oswald) G.m.b.H. und Co. K.G., Gladbeck (Germany, F.R.).
H. Sixt, and P. A. Wilderer.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 627-636, 9 Fig, 5 Tab, 17 Ref.

Descriptors: *Wastewater treatment, *Sludge digestion, *Industrial wastewater, Sludge, Anaerobic digestion, Design criteria, Performance evaluation, Chemical wastewater, Cotreatment.

The potentials, requirements and benefits of co-treatment of wastewater sludge and highly polluted wastewater in egg-shaped digestors are discussed. This reactor shape provides structural as well as operational advantages. In particular, mixing of the reactor content can be accomplished most effectively, and the energy required to achieve uniform distribution of the reactants is relatively low. Effective mixing is a crucial factor as far as process stability is concerned. This is especially true when solid and liquid wastes are planned to be treated jointly. Local peak concentrations within the reactor can be effectively avoided. The applicability of co-treatment of industrial wastewater and municipal wastewater sludge depends on a number of factors besides perfect mixing. The wastewater to be treated must be low in volumetric quantity compared to the volumetric quantity of the sludge to be treated but rich in easily digestible substrates. The digester, on the other hand, must provide extra capacity. Chemostat conditions must be maintained. The situation in Lahr, Germany, is considered to be almost ideal to investigate the potentials of joint treatment of wastewater and sludge. The technique currently in use is described and preliminary findings are

summarized. The results warrant further investigations.
W85-05550

USE OF LONG SOLIDS RETENTION TIMES TO IMPROVE THE ACTIVATED SLUDGE BIODEGRADATION OF A COMPLEX WASTE,
South Dakota School of Mines and Technology, Rapid City.
K. Hagelstein, and R. R. Dague.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 637-642, 5 Fig, 3 Tab, 11 Ref.

Descriptors: *Wastewater treatment, *Retention time, *Activated sludge process, Biological treatment, Pyrolysis waste, Organic carbon, Suspended solids, Biological oxygen demand, Effluents, Toxicity, Daphnia, Monitoring, Biodegradation.

Sludge retention times (SRTs) > 10 days produced effluents with reduced total organic carbon (TOC), biological oxygen demand (BOD), and suspended solid (SS) after activated sludge processing of this complex waste. The advantage of long retention times is the higher concentration of biological solids which is responsible for either higher assimilative or adsorptive removal of the organics. Practically, larger activated sludge units may have to be designed to apply this treatment enhancement. Daphnia magna toxicity tests with 100% effluent from the pyrolysis waste activated sludge units supported the conclusion that long sludge ages (20 and 40 day SRTs) provided more efficient treatment and greatly reduced the toxicity of the complex waste than did the 10 day SRT system. The long SRT activated sludge systems adequately eliminated the toxicity of the pyrolysis waste from a LC50 equaling 0.33% to 100% survival of daphnids in 100% effluent. Therefore, the toxicity testing of an effluent rather than an individual chemical, was successfully applied as a monitoring method to be compared to standard efficiency measurements.
W85-05551

APPLICATION OF CARRIER/ACTIVATED SLUDGE PROCESS FOR TREATMENT OF PHENOLIC WASTEWATER,
Toronto Univ. (Ontario). Dept. of Civil Engineering.
Y. Lu, and J. J. Ganczarczyk.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 643-657, 7 Fig, 8 Tab, 8 Ref.

Descriptors: *Wastewater treatment, *Activated sludge process, Phenols, Biological treatment, Activated carbon, Coke, Sludge volume index, Biomass, Effluents, Clarifiers, Organic compounds, Substrates.

A hybrid biological process based on the use of suspended carrier particles for biological growth is shown to be a viable modification of activated sludge treatment. It is superior to the activated sludge process operating without a carrier addition as it allows for maintaining a higher biomass concentration in aeration tanks, helps control sludge volume index, and improves substrate removal rates. Two different types of carrier particles were investigated: activated carbon and coke. They differed substantially in their sorption capacity, but this did not affect the process performance under its equilibrium conditions. However, under fluctuating loading conditions, the activated carbon system proved to be much superior in maintaining a stable operation and continuously high effluent quality, apparently due to its higher sorption capacity. The studied process differs from the powdered activated carbon (PAC) activated sludge by an application of larger size carrier particles which can be regenerated by an in-the-system or separate aerobic digestion process, and then recycled back to the treatment reactor. Use of these carrier particles should not create any problems in installations equipped with integrated clarifiers. For those with separate clarifiers, a proper selection of recirculation pumps is required.
W85-05552

ACTIVATED SLUDGE WITH POWDERED ACTIVATED CARBON TREATMENT OF A DYES AND PIGMENTS PROCESSING WASTEWATER,
Industrial Environmental Research Lab.-Cincinnati, OH.
G. M. Shaul, M. W. Barnett, T. W. Neiheisel, and K. A. Dostal.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 659-671, 4 Fig, 7 Tab, 8 Ref.

Descriptors: *Wastewater treatment, *Dye industry wastes, *Pigments, *Activated sludge process, *Biological treatment, Activated carbon, Biological oxygen demand, Chemical oxygen demand, Organic carbon, Color removal, Toxicity, Effluent, Suspended solids, Lead, Chromium, Metals, Clarifiers.

This study was designed to evaluate the treatability of a dyes and pigments processing wastewater using an activated sludge (AS) process both with and without the addition of powdered activated carbon (PAC). The activated sludge process removed 50 to 98% of the toxicity as measured by three test organisms, and the addition of powdered carbon increased the removal of toxicity in all cases. The activated sludge process (no PAC) reduced the BOD by 97 to 98% (based upon total influent and soluble effluent) at solids retention times ranging from 4 to 16 days. The AS process reduced the COD and TOC (based upon soluble effluent) by 57 to 75% and 56 to 64% resp. The AS process removed very little of the color, from 0 to 34%. Addition of powdered activated carbon to the activated sludge process increased the removals of BOD, COD, TOC and color with removal ranges of 99 to > 99%, 63 to 96%, 61 to 87%, 0 to 96%, resp. The additional removal of organics by the powdered carbon was a function of the amount of carbon added. The powdered carbon did not improve the removal of soluble lead and chromium, although it did improve the removal of suspended solids in the secondary clarifier.
W85-05553

ANAEROBIC TREATMENT OF TANNERY WASTE,
Agricultural Research Service, Philadelphia, PA. Eastern Regional Research Center.
D. G. Bailey, M. H. Tunick, A. A. Friedman, and G. B. Rest.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 673-682, 13 Fig, 4 Tab, 9 Ref.

Descriptors: *Wastewater treatment, *Tannery wastes, *Anaerobic digestion, *Rotating biological contactors, Chemical oxygen demand, Sulfide, Aerobic treatment, Effluents, Methane, Retention time, Hydraulic loading, Biological filters.

Anaerobic roughing treatment followed by aerobic polishing may be suitable for application to tannery wastewaters. Sixty per cent total chemical oxygen demand removals were routinely obtained with both systems. In addition, there is evidence that the anaerobic effluents are readily degraded aerobically and that methane gas recovery plus heat exchange should minimize or negate the energy input needed to maintain the reactor at 37 C. Hydraulic retention times of < 24 hrs. were demonstrated with the anaerobic filters (AF). There is also evidence that anaerobic treatment processes are inherently stable. Data generated by the anaerobic contact (AC) and the AF treatment of tannery wastes showed the anaerobic processes tested to be resistant to hydraulic variations and upsets. On several occasions both the AF and the AC organisms were exposed to oxygen through mechanical difficulties. Restarting either system was generally rapid and required only a few days. Despite reactor sulfide levels as high as 600 mg/l, normally considered toxic, the AC system continued to produce methane. Problems observed in this work on anaerobic treatment should not be ignored. Initial anaerobic startup requires a long period of time (up to six mo). The tannery wastewaters studied presented a particular problem due to the formation of inorganic precipitates. They were sufficient to clog the AF and close down the space between discs on the bench scale rotating biological contactors. This result would favor a suspended growth AC process over the AF for tannery wastewaters.
W85-05554

EFFECT OF ANAEROBIC CONDITIONS ON ACTIVATED SLUDGE SETTLEABILITY,
Kapur and Associates, Inc., Waukesha, WI.
Y.-H. Ni.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 683-691, 8 Fig, 2 Tab, 15 Ref.

Descriptors: *Wastewater treatment, *Sludge bulking, *Activated sludge process, Organic carbon, Phosphorus, Anaerobic digestion, Aerobic digestion, Organic loading, Sedimentation, Sludge volume index.

The objectives of this study were to determine the loading parameters of an anaerobic-aerobic system that induced sludge bulking. For anaerobic-aerobic sludge systems having an anaerobic volume to aerobic volume ratio of 0.4 or greater (30% or greater anaerobic volume of the total volume) and having an organic loading of 0.2 lb total organic carbon/lb MLSS, serious settleability problems developed and were primarily due to filamentous organisms. The settleability problems were severe enough to cause process failure. For anaerobic-aerobic activated sludge systems operating at ratios of < 0.4, filamentous sludge bulking did not occur. However, the sludge volume indexes (SVI) were not as good as the completely aerobic system (control). Reaeration of a previous anaerobic reactor of a severely bulking activated sludge system improved the settleability of the MLSS. The SVI went from 450 ml/g to a near normal 80 ml/g (compared to the control) in 5 days. Sludge bulking did not affect the organic removal efficiencies. A removal efficiency of > 90% was obtained through the entire test period. In all of the anaerobic to aerobic volume ratios tested, the 'luxury uptake of phosphorus' was not observed. The soluble phosphorus removals ranged fro 23 to 35%.
W85-05555

NEAR ZERO D.O. ACTIVATED SLUDGE CASE HISTORY,
Weyerhaeuser Co., Tacoma, WA.
W. A. Barkley, R. W. Sackellare, J. R. Ellavsky, R. D. Simmon, and J. W. Yount.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 693-704, 10 Fig, 1 Tab, 15 Ref.

Descriptors: *Wastewater treatment, *Pulp and paper industry, *Activated sludge process, *Dissolved oxygen, Sludge bulking, Sludge volume index, Yount filament count, Biological oxygen demand, Clarifiers, Suspended solids, Chlorine, Suspended solids, Aerators, Economic analysis.

Information on operating experiences with a new zero dissolved oxygen (DO) activated sludge treatment of pulp and papermaking wastewater at Weyerhauser's Longview, Washington facility is presented. Operation at a near zero DO concentration in an aerobic system with forced oxygen transfer has been demonstrated. To prevent sludge bulking, chlorine oxidizing agents were added to the return activated sludge line to eliminate filamentous organisms. This (1) resulted in greater system controllability, (2) successfully eliminated float incidents; and (3) controlled sludge volume index (SVI) and Yount filament count (YFC) to desired set points. Decreased soluble BOD removal in the aeration tank has been offset by improved clarifier total suspended solids quality. Oxygen use efficiencies have more than doubled (35-40% now). Savings from blower electrical costs alone equal about $200,000/year.
W85-05556

FATE OF NITRATE IN A SINGLE STAGE NITRIFICATION ACTIVATED SLUDGE SYSTEM,

Merck and Co., Inc., Rahway, NJ.
R. T. Donahue, and J. L. Pintenich.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 705-714, 4 Fig, 7 Tab, 1 Ref.

Descriptors: *Wastewater treatment, *Pharmaceutical wastes, *Nitrification, Denitrification, Activated sludge process, Nitrates, Dissolved oxygen, Effluents, Suspended solids, Biological oxygen demand, Chemical oxygen demand, Sludge, Filters.

Substantial nitrification and denitrification were quantified in bench-, pilot-, and full-scale single stage activated sludge systems treating a pharmaceutical wastewater. Denitrification occurred at mixed liquor dissolved oxygen concentrations as high as 6.0 mg/l in batch aeration tests conducted supplementary to these investigations. Study results, expressed graphically in the form of percentage nitrogen imbalance, are summarized. For purposes of comparison, the range of nitrogen balance closure data reported by Luthy and Jones for treatment of a coke plant wastewater is also presented. Their reported range of 0 to 12% is representative of the closure accuracy expected for a nitrification system operating without denitrification. While elevated dissolved oxygen levels generally tend to suppress the denitrification process, an oxygen gradient existed in the activated sludge systems discussed, thereby allowing for anoxic denitrification in some parts of the biological floc. These anaerobic zones are postulated to occur in the floc centers. This hypothesis is plausible for this pharmaceutical waste since the feed to the activated sludge units contained significant concentrations of sloughed solids from the upstream roughing filter, which provided opportunity for the growth of activated sludge flocs with large diameters.
W85-05557

INFLUENCE OF ORGANIC SHOCK LOADS ON THE PERFORMANCE OF AN ANAEROBIC FLUIDIZED BED SYSTEM,

New South Wales Univ., Kensington (Australia). School of Civil Engineering.
D. Barnes, P. J. Bliss, B. Grauer, E. M. Kuo, and K. Robins.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 715-723, 11 Fig, 1 Tab, 23 Ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Fluidized beds, *Shock loads, Biochemical oxygen demand, Organic acids, Volatile acids, Industrial wastewater, Hydrogen ion concentration, Hydrogen.

The response of an anaerobic fluidized bed system to shock loads of high biological oxygen demand (BOD) concentration (ranging from 8,700 mg/liter to 45,700 mg/liter) imposed over a 1-hr period is reported. The shock loads were chosen so that the total load did not exceed twice the average daily load for continuous reliable operation. A synthetic wastewater was used. For small shock loads (three times a designed load of approximately 12 kg BOD/cu m bed/day), the system exhibited little disruption and continued to provide a high decree of treatment. For high BOD loads, 10-20 times the designed load, the system was stimulated to produce the intermediate products, acetic acid, propionic acid, and hydrogen. These intermediates were converted to the end products but the microbial mass required a finite time to re-adjust to these transients. Once the anaerobic fluidized bed has recovered from a major shock load, it returns to its normal stable operation and will respond in a similar manner to a similar shock load. The stability and response of the reactors could be judged from both the overall performance of the system and the concentrations of intermediates and end products. While total volatile acid concentrations stabilized at continuous loading to reflect the substrate and reaction system, the increase in acids after an organic shock load can be monitored relatively easily by direct measurement and as the pH value. The concentration of the individual intermediate, acetic acid, propionic acid, and hydrogen and particularly the hydrogen gas yield, showed a rapid response to process changes. The recovery of the fluidized bed system suggests that it is suitable for treating wastes of a variable nature but for maximum substrate removal efficiency some form of load equalization is desirable.
W85-05558

RESPONSE OF PHENOL-ACCLIMATED ACTVATED SLUDGE PROCESS TO QUANTITATIVE SHOCK LOADING,

Delaware Univ., Newark. Dept. of Civil Engineering.
A. F. Rozich, and A. F. Gaudy.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 725-736, 7 Fig, 2 Tab, 29 Ref.

Descriptors: *Wastewater treatment, *Mathematical models, *Phenols, *Shock loads, Activated sludge process, Inhibitors, Organic compounds, Kinetics, Detention time.

The kinetic model can be used as an aid in understanding the behavior of the activated sludge process. The use of the model in transient analysis showed the engineering wisdom of employing an inhibitor function when designing for phenolic wastes. From a practical engineering point of view, it is clear that successful treatment calls for design of low, rather than high, specific growth rates and for providing the operator with the means to keep the specific growth rate low, regardless of the changing influent conditions. An examination of the model equations showed that in addition to the five biokinetic constants, there are four engineering parameters which affect mu and thus Se. Mu can be kept low by using relatively high levels of return sludge and providing for higher hydraulic recycle flow, alpha, and a longer detention time, t(1/D). An equalization basin can be used to level out the temporary highs in Si thus lowering the level of growth rate to which the system is subjected.
W85-05559

BIOLOGICAL TREATABILITY OF PHOTOPROCESSING WASTEWATER: PART I,

Cincinnati Univ., OH. Dept. of Civil and Environmental Engineering.
R. N. Kinman, K. McKee, B. Mackey, D. L. Nutini, and N. Neely.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 737-749, 7 Fig, 16 Tab.

Descriptors: *Wastewater treatment, *Photoprocessing wastewater, *Activated sludge process, *Microorganisms, Biological treatment, Biological oxygen demand, Chemical oxygen demand, Sludge, Effluents, Contact stabilization.

Data from the operation of a control plant and a test plant treating photoprocessing wastewater are presented and indicate that photoprocessing wastewater is amenable to biological treatment. The test receiving 4% by volume photoprocessing wastewater, which resulted in higher BOD and COD loadings, produced a satisfactory and typical contact stabilization activated sludge effluent very similar to the control plant effluent. No problems were encountered in treating the waste by the contact stabilization activated sludge process. Microorganisms were similar in both plants and indicated a well balanced micro flora and fauna.
W85-05560

ATP AS A MEASURE OF ACTIVE BIOMASS CONCENTRATION AND INHIBITION IN BIOLOGICAL WASTEWATER TREATMENT PROCESSES,

McNamee, Porter and Seeley, Ann Arbor, MI.
S. J. Kang, L. B. Pugh, and J. A Borchardt.

In: Proceeding, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 751-759, 10 Fig, 11 Ref.

Descriptors: *Wastewater treatment, *Inhibition, *Biomass, *Activated sludge process, *Rotating biological contactors, Volatile solids, Biocides, Substrates, Nitrification, Dissolved oxygen, Hydrogen ion concentration, Biological treatment, Copper, Zinc, Lead.

Based on experiments conducted both on pilot scale and full scale municipal waste treatment processes, adenosine triphosphate (ATP) is an accurate and reliable method of measuring active biomass concentration. Using autotrophic nitrifying cultures, the relationship between ATP and substrate utilization rate was established. Effects of pH and dissolved oxygen on nitrification were also reproduced by ATP measurement. The utility of ATP was demonstrated both in activated sludge and rotating biological contactors (RBCs). The relationship among ATP, film thickness, and volatile solids was observed for three stages of RBCs and it was shown that the biomass activity as measured by ATP exhibits a rapid growth before the presence of a significant layer of biofilm. The specific ATP content (ATP per unit weight of VSS) was observed to be 0.33 mg/g VSS in the first stage and 0.6 mg/g VSS in the second and third stages. The lower value for the first stage is due to the presence of nonactive biomass in the outer layer and anaerobic organisms in the inner layer. Because of the advantages of the ATP methodology, it can be a useful tool in identifying the presence of inhibitory substances in the feed for biological cultures. The mechanism of inhibition can be identified by observing the relationship between the ratio between normal and inhibited growth rate and inhibitor concentration. This was demonstrated for known inhibitors: copper, an admixture of zinc and lead, and organic wastes containing biocide.
W85-05561

TREATMENT OF APPLE PROCESSING WASTEWATER BY THE ANAEROBIC FILTER PROCESS,

Northeastern Univ., Boston, MA. Dept. of Civil Engineering.
M. J. Laquidara, and C. R. Ott.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 761-767, 8 Fig, 1 Tab, 6 Ref.

Descriptors: *Wastewater treatment, *Biological filters, *Waste treatment, *Food processing wastes, Anaerobic digestion, Biochemical oxygen demand, Methane, Phosphorus, Nitrogen, Chemical oxygen demand, Temperature effects, Nutrients, Detention time, Effluents, Operating costs, Energy efficiency.

The objectives of this study were to determine the treatment capabilities of the anaerobic filter process when fed a mid-strength apple processing wastewater as a function of: (1) operating temperature; (2) nutrient content; and (3) hydraulic detention time. With respect to nutrients the waste had abundant phosphorus but was severely limited in nitrogen. Anaerobic filter treatment efficiency was maximum at 35 C and efficiency decreased with decreasing temperature. Treatment efficiencies (based on COD removal) of 90% and above are possible with waste strengths of 2,000 mg/liter, a one-day detention time. Effluent BOD values only slightly higher than secondary treatment standards can be produced. This implies that, while effluent polishing would be required treatment would be minimal. Because methane gas is produced, it could be used to help maintain the filter's operating temperature. COD/N ratios as high as 150 are acceptable. This ratio is significantly higher than for aerobic systems, and since this waste is nitrogen deficient a savings in nutrient supplement cost would be realized. The system can be very energy efficient. Frictional headloss through the filter was negligible, even after seven months of operation; thus, energy for pumping is mainly a function of system layout.
W85-05562

OXIDATION OF A CORN-MILLING WASTEWATER WITH HYDROGEN PEROXIDE,

Arizona Univ., Tucson. Dept. of Civil Engineering.
D. deRoulhac, G. L. Amy, and N. C. Burbank.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 769-780, 5 Fig, 3 Tab, 12 Ref.

Descriptors: *Wastewater treatment, *Food-processing wastes, Hydrogen peroxide, Fenton reaction, Zein prolamine, Infrared spectroscopy, Organic compounds, Flocculation, Hydrogen ion concentration, Cost analysis.

A study was conducted to determine if the Fenton reaction would be useful in breaking down zein, a corn prolamine protein, and thereby useful in treating cornmilling wastewater. Infrared spectra were inconclusive in following zein because (1) different solvents and (2) other organics masked the anticipated zein spectrum. The results indicated that the use of Fenton's reagent can remove organic matter from a corn-milling wastewater by a combination of: (1) ferrous ion catalyzed H202 oxidation; and (2) ferric hydroxide flocculation. However, the doses and pH conditions required for a 44% reduction in NVTOC (H202 = 250 mg/liter, FeSO4 = 25 mg/liter, and pH = 3.0) do not constitute a basis for a cost/effective pretreatment scheme.
W85-05563

ANAEROBIC-AEROBIC TREATMENT OF A WHEAT STARCH PLANT EFFLUENT: A CASE HISTORY,

Sorigona, Inc., Woodbury, NY.
W. A. Bonkoski, J. E. Sointio, and G. R. Gillespie.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 781-787, 2 Fig, 6 Tab, 5 Ref.

Descriptors: *Wastewater treatment, *Wheat, *Food processing wastes, Anaerobic-aerobic treatment, Biological treatment, Iron, Cost analysis, Methane, Nutrients, Biological oxygen demand, Chemical oxygen demand.

The selection, installation and start-up of a combined anaerobic-aerobic system designed to handle wastewater from the wheat starch facility operated by Industrial Grain Products, Ltd. at Thunder Bay, Ontario is described. The anaerobic part of the system is both a net energy producer and a net cost reducer due to the production of methane gas and the elimination of the necessity to dry bran by heating it. Experience in the initial stages of start-up showed that the wastewater was deficient in certain micronutrients, particularly iron. Although start-up of the wastewater treatment plant is not yet completed, critical process control parameters have reached suitable levels and it is expected that the remainder of the plant start-up will proceed in a fashion similar to other full scale installations.
W85-05564

PERFORMANCE OF A POTATO PROCESSING WASTEWATER TREATMENT PLANT: A CASE HISTORY,

Regina Univ. (Saskatchewan). Faculty of Engineering.
T. Viraraghavan, R. C. Landine, and A. A. Cocci.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 789-803, 2 Fig, 12 Tab, 2 Ref.

Descriptors: *Wastewater treatment, *Food-processing wastes, *Potatoes, Clarifiers, Trickling filters, Biological oxygen demand, Load distribution, Hydrogen ion concentration, Sludge, Mud water.

This paper presents an analysis of the data collected in the monitoring program for the purpose of identifying the causes of the poor performance of the treatment facility for a large potato processing plant. High efficiency of BOD removal occurred when the trickling filter was operating below its design capacity of 5 kg BOD/m3/day. When this loading rate was exceeded, removal efficiency dropped to between 10 and 40%. Mud water impacts on the treatment system, increases organic load, fine and colloidal matter affecting trickling filters, toxic chemicals and heavy metals in its stream impacting on the biological system. Independent treatment and disposal of mud water should be seriously considered. The poor performance of the primary clarifier (in respect of BOD removal) was due to change in wastewater characteristics; the long storage time for sludge, pH shifts and dissolution of solids results in increases in soluble BOD. Toxicity by chemicals, pH variations, and mud water contributed to the poor performance of the trickling filter system which was already under stress because of excessive loading rates. There is a need for a pretreatment system interposed between the primary clarifier and the trickling filter system to reduce the load on trickling filters.
W85-05565

ANAEROBIC PRETREATMENT FACILITY ALSO PROVIDES SLUDGE DISPOSAL CAPABILITY AND SOURCE OF RENEWABLE ENERGY FOR FOOD PROCESSOR,

ADI Ltd., Fredericton (New Brunswick).
R. C. Landine, C. J. DeGarie, A. A. Cocci, A. L. Steeves, and G. J. Brown.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 805-815, 9 Fig, 4 Tab.

Descriptors: *Wastewater treatment, *Food processing wastes, *Potatoes, Anaerobic-aerobic treatment, Biological treatment, Methane, Biological oxygen demand, Chemical oxygen demand, Suspended solids, Activated sludge process, Ammonia, Nitrogen compounds, Denitrification, Aerobic treatment, Operating costs.

This paper describes the design loadings and unit operations of a combined anaerobic-aerobic facility for treating potato processing wastewater. The entire treatment facility was economical to construct and simple to operate, requiring only two operators. The monetary value of the methane biogas recovered is greater than all the operating costs including labor, chemicals, electricity, maintenence, discharge tax and sundries. The anaerobic portion of the plant, an ADI-BVF, provided > 90% removal of BOD, COD and SS while operating under higher loadings than assumed for design and at temperatures < 20 C. The ADI-BVF is operating without any addition of chemicals or heat. Primary and secondary sludge are disposed in the ADI-BVF where they are anaerobically decomposed to enhance biogas production. No sludge of any kind has been removed from the facilities after two years of operation, nor is there any evidence of a need to remove sludge in the near future. Biogas is recovered and used in the factor boilers to make process steam. The activated sludge plant removed over 90% of the BOD and ammonia. Overall removals were: COD 98%, BOD 99.5%, SS 98% and total nitrogen 80%. High nitrogen removals were attributed to denitrification in the aeration plant.
W85-05566

RECOVERY AND APPLICATION OF SOLIDS FROM CRAB-PROCESSING WASTEWATER,

North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
A. C. Chao, L. Tzou, and C. T. Young.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 829-838, 11 Fig, 2 Tab, 12 Ref.

Descriptors: *Wastewater treatment, Food-processing wastes, *Ultrafiltration, Feed additives, Byproducts, Organic compounds, Suspended solids, Amino acids.

The organic substances in the crab-processing wastewater can be concentrated by use of an ultrafiltration process. This paper presents an equation to calculate the concentrate factor of the ultrafiltration process (C.F.) versus the operating time (t). Comparison of the calculated and the experimental data shows that the proposed equation is valid in predicting the time needed for the ultrafiltration process to achieve certain concentration factor levels. The quantity or the concentration of organic substances in the concentrate stream can then be calculated based on the known concentration factor. The calculated concentration of suspended solids in the concentrate stream were also checked by the experimental results. The quality of the concentrated organic matter was indicated by its amino acids compositions. The results indicate that the recovered organic substances contain all the essential amino acids and can be considered as nutritious as soy bean meal. Since it does not contain heavy metals nor mutagenic substances that may cause long-term health hazards, the recovered material can be used as feed additives, biological reactor feed solution additives, or dietary supplement.
W85-05567

ALASKA SEAFOOD PROCESSING INDUSTRY,

Alaska Univ., Fairbanks. Dept. of Environmental Quality Engineering.
T. Tilsworth, and W. D. Morgan.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 847-854, 1 Fig, 2 Tab, 19 Ref.

Descriptors: *Wastewater treatment, *Food processing wastes, *Seafood processing wastewater, Alaska, Solids, Byproducts, Economic aspects, Hydrocyclones, Water reuse, Water conservation.

This report is an overview of the seafood industry and its environmental and economic considerations in Alaska. The Alaska seafood industry is a major component of the state's employment force and economy. Processing of the industrial waste must be balanced with reasonable but adequate protection of the environment. Treatment technology exists to accomplish this objective economically and hydrocyclones appear to be promising in this regard. Environmental regulations for this industry are still being promulgated, and the industry must be prepared to adapt to them. Solids removal prior to disposal is essential in order to reduce pollution, enhance byproduct recovery, and permit water conservation and reuse. Byproduct recovery is a consideration which should be given more weight and evaluation.
W85-05568

FAST-TRACK DESIGN, CONSTRUCTION, AND START-UP OF A CHEESE MANUFACTURE WASTEWATER PRETREATMENT PLANT,

CH2M/Hill, Denver, CO.
R. W. Davis, and H. K. Houmes.

In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 855-861, 1 Fig, 1 Tab.

Descriptors: *Wastewater treatment, *Food-processing industry, *Dairy industry, Construction, Design criteria, Biological filters, Biological treatment, Management planning.

The design, construction and start-up of the combined fast-track and phased management approach of a cheese wastewater pretreatment plant is described. Major and long-lead equipment was prepurchased by the owner. The biological filter tower media, tankage and clarifier mechanisms were identified as critical, long-lead equipment. Structural designs incorporated standard components available in the area; however, flexibility was designed into each component to allow adaptation to a connecting or appurtenant component. The earthwork, concrete structures, and electrical work was phased to meet the startup and treatment requirements during the course of the project. The biological treatment system was built within twelve weeks without stopping either the old physical chemical treatment plant or cheese production.
W85-05569

AQAT: A MOBILE WASTEWATER TREATABILITY ASSESSMENT SYSTEM,
Conoco, Inc., Ponca City, OK.
J. R. Wolfe, R. L. Huddleston, and L. W. Cresswell.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 915-918, 2 Fig.

Descriptors: *Wastewater treatment, *Pilot plants, Activated sludge process, Rotating biological contactors, Biological wastewater treatment, Automation, Activated carbon, Ozonation, Filters, Ion exchange, Gas chromatography, Spectrophotometry.

AQAT (Aquatic Quality Assurance Trailer) is a complete, mobile, state-of-the-art pilot wastewater treatment system with both complete treatment and analytic equipment. The system consists of an equalization tank, two dissolved air flotation units, four small-scale activated sludge units, a rotating biological contactor, four granular activated carbon columns, a multimedia filtration column, two ion exchange columns, and an ozonation unit. Treatment performance closely approximates that of a full-scale system so that scale-up problems are minimized. Four studies (at a PVC plant, two refineries, and a chemical plant) have been completed successfully. The AQAT has proved to be a versatile and useful tool for wastewater treatability studies.
W85-05573

DEVELOPMENT AND VALIDATION OF A WASTE STRENGTH EQUALIZATION BASIN DESIGN TECHNIQUE,
Illinois Inst. of Tech., Chicago. Pritzker Dept. of Environmental Engineering.
J. P. Menez, and J. W. Patterson.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, Ma. p 919-929, 11 Fig, 5 Tab, 7 Ref.

Descriptors: *Wastewater treatment, *Equalizing basins, *Waste load, *Design criteria, Shock loads, Influent streams, Effluents, Computer models, Retention capacity.

A study was conducted to develop and evaluate a simple design procedure for waste strength equalization, by correlating the characteristics of the fluctuating influents with the equalized effluents as a function of the instantaneous basin detention time of the waste. A completely mixed equalization basin was used to simulate the performance of a unit receiving an influent randomly varying in both flow rate and waste strength. Design models were developed and validated against the results of a laboratory pilot scale equalization unit. To select the optimum volume of basin, efficiency curves were constructed for both concentration and mass loadings. The design equations have been further evaluated by computer simulation, and the results indicate that the apparent disparate objectives of simultaneous equalization of waste concentration and waste flow rate can be economically achieved. Waste strength equalization, when accomplished with a constant liquid volume in the equalization basin, is an efficient method to dampen the concentration and the mass loading of the waste. Large retention volume to equalize waste strength fluctuations does not appear to be necessary because there is little or no efficiency gained by such an increase in the volume of the basin. For the cycles studied, a retention volume of about one third of total cycle inflow was usually sufficient to achieve economical waste strength equalization.
W85-05574

POLLUTION CONTROL IMPLICATIONS OF FLUIDIZED BED TECHNOLOGY FOR COAL-FIRED STEAM ELECTRIC POWER GENERATION.
CH2M Hill Canada Ltd., Calgary (Alberta).
For primary bibliographic entry see Field 5C.
W85-05575

TOXIC METAL REMOVAL FROM ELECTROPLATING WASTEWATER USING SILYLATED SILICA GEL,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
P. G. Malone, and R. A. Karn.
Available from the National Technical Information Service, Springfield, VA 22161, as AD/A120 030, Final Report, September 1982. Miscellaneous Paper EL-82-3. 27 p. 4 Fig, 8 Tab, 14 Ref. Project No. 4A161101A91D.

Descriptors: *Wastewater treatment, *Metal-finishing wastes, *Copper, Silica, Gels, Chromium, Nickel, Zinc, Cadmium, Costs.

A preliminary study was undertaken to evaluate the usefulness of silylated silica gel in removing toxic metals from electroplating wastewater. A number of complexing and chelating systems immobilized on silica gel are available. Most involve relatively complicated syntheses, produce materials that are not stable at room temperature for long periods of time, or have very low metal removal capacities. An immobilized diamine produced from N-(beta-aminoethyl)-gamma-aminopropyl-trimethoxysiline was found that could be prepared using a simple procedure and could be stored at room temperature without deterioration. Samples of material prepared in the laboratory could remove 22-24 Cu per gm silica gel. Small-scale column studies using samples of electroplating wastewater showed that levels of Cd, Cr, Cu, Ni and Zn could be reduced significantly. Cost estimates based on the coating system used in this study show that $0.124 worth of silane are required to remove 1 gm Cu. Theoretically, the costs could be reduced to $0.052/gm Cu removed. Metals removed on immobilized diamine can be recovered by stripping the silica gel column with strong oxidizing acid. The diamine coating can be replaced by treating the silica gel with additional silane. The stability, ease of preparation, and ability to recover metals make immobilized diamine a useful system for electroplating wastewater treatment.
W85-05579

CHARACTERIZATION AND TREATABILITY OF DRAINAGE SAMPLES FROM COAL PILES AT STEAM ELECTRIC POWER STATION.
Dearborn Environmental Consulting Services, Mississauga (Ontario).
For primary bibliographic entry see Field 5A.
W85-05594

EFFECTS OF NITRATE, PHOSPHATE AND POTASSIUM FERTILIZATION ON GROWTH AND NUTRIENT UPTAKE PATTERNS OF PHRAGMITES AUSTRALIS (CAV.) TRIN. EX STEUDEL,
Michigan State Univ., East Lansing. Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W85-05609

NITROGEN AND PHOSPHORUS REMOVAL BY CYPRESS SWAMP SEDIMENTS,
Florida Inst. of Tech., Melbourne. Dept. of Environmental Sciences and Engineering.
F. E. Dierberg, and P. L. Brezonik.
Water, Air, and Soil Pollution, Vol. 24, No. 2, p 207-213, February, 1985. 3 Tab, 18 Ref.

Descriptors: *Nitrogen removal, *Phosphorus removal, *Sediments, *Cypress swamps, Wastewater treatment, Nitrates, Leaching, Ammonium, Swamps, Wetlands.

Removal of nutrients from wastewater (effluent) by sediments in cypress swamps was studied in laboratory leaching columns filled with wet surface sediments. Columns were leached with low-nutrient groundwater, treated wastewater, and treated wastewater amended with nitrate (20 to 30 mg N/L) and phosphate (9.5 mg P/L) for 21 mo. From 99 to 100% of the nitrate-nitrate and P was removed from the amended wastewater eluants throughout the investigation; average concentrations of nitrate-nitrate and P in effluent from amended wastewater columns did not exceed concentrations in leachate from columns eluted with groundwater. Ammonium removal was approximately 50% in columns receiving treated wastewater. Sediments of cypress swamps have a large capacity to remove nutrients from secondary effluent. (Author's abstract)
W85-05695

KINETIC LIMITATIONS ON THE SELECTIVE PRECIPITATION TREATMENT OF ELECTRONICS WASTES,
Illinois Inst. of Tech., Chicago. Pritzker Dept. of Environmental Engineering.
S. B. Karra, C. N. Haas, V. Tare, and H. E. Allen.
Water, Air, and Soil Pollution, Vol. 24, No. 3, p 253-265, March, 1985. 8 Fig, 6 Tab, 8 Ref.

Descriptors: *Electronics industry, *Industrial wastewater, *Precipitation, Kinetics, Wastewater treatment, Chromium, Lead, Nickel, Fluorides, Tartrates, Citrates, Waste age.

The precipitation of metals was studied in a synthetic wastewater simulating the composition of semiconductor manufacturing. Equilibrium information does not suffice to specify the process due to the kinetic limitations resulting from the formation of highly stable metal complexes. Maximum removals of Cr, Pb, and Ni can be obtained by precipitation processes, if the wastewater is treated soon after it is generated. The removal of Cr was significantly and adversely affected by waste aging due to the slow rate of dissociation of Cr-fluoride complexes once they are formed. Segregation of Cr bearing wastes from other wastewaters will improve the efficiency of Cr removal by precipitation, if the wastewater is to be stored for a period before treatment. The effect of waste age on Cr removal is approximated by the theoretical results obtained using the MINEQL model modified for kinetic limitations. Citrate and tartrate inhibit the precipitation of Pb and Cu. The removal of Ni was not kinetically limited; however, the observed removals were higher than the removals predicted. (Moore-IVI)
W85-05698

FULLER'S EARTH AND FIRED CLAY AS ADSORBENTS FOR DYESTUFFS; EQUILIBRIUM AND RATE STUDIES,
Queen's Univ., Belfast (Northern Ireland). Dept. of Chemical Engineering.
G. McKay, M. S. Otterburn, and J. A. Aga.
Water, Air, and Soil Pollution, Vol. 24, No. 3, p 307-322, March, 1985. 13 Fig, 4 Tab, 14 Ref.

Descriptors: *Fire clay, *Fullers earth, *Adsorbents, *Dye industry wastes, Dyes, Wastewater treatment, Industrial wastes, Astrazone Blue, Telon Blue, Kinetics, Temperature, Agitation.

There is considerable need to treat colored effluents, such as dyehouse wastes, prior to their discharge into receiving waters. Fuller's earth and fired clay were studied to determine their potential to remove a basic dye (Astrazone Blue - Basic Blue 69) and an acidic dye (Telon Blue - Acid Blue 25). The adsorption capacities of a fired clay were 7 mg dye/g fired clay and 40 mg dye/g fired clay for Telon Blue and Astrazone Blue, respectively, indicating its use in treating dyehouse effluents is of little or only very limited significance. The equilibrium saturation adsorption capacities were 1200 mg dye/g Fuller's earth and 220 mg dye/g Fuller's earth for Astrazone Blue and Telon Blue, respectively. The kinetics of the adsorption processes were studied in an agitated batch adsorber. The 90% equilibrium value was achieved in less than 1 h. Increased agitation increased the rate of dye adsorption. Increasing the initial dye concentration increased the treated effluent outlet concentration for a given mass of adsorbent. Decreasing particle size increases the rate of dye adsorption and increased temperature increases the initial rate of adsorption. (Moore-IVI)
W85-05701

ADVANCED MEMBRANE FILTRATION PROCESS TREATS INDUSTRIAL WASTEWATER EFFICIENTLY,
Memtek Corp., Woburn, MA.
T. V. Tran.
Chemical Engineering Progress, Vol. 81, No. 3, March, 1985. 3 Fig, 4 Tab, 5 Ref.

Descriptors: *Wastewater treatment, *Membrane filtration, *Industrial wastewater, Membrane processes, Radioactive wastes, Particulate matter.

Advances in membrane filtration processes have made this technology an acceptable method for effectively treating industrial wastewater. The superior performance level resulting from chemical pretreatment combined with membrane filtration enables this process to be successfully used by a number of industries. The concentration of contaminants in discharge water after treatment by membrane filtration is consistently below current discharge limits and in many cases makes the water suitable for recycling. This margin of safety makes the use of membrane filtration suitable for today's industrial environment as well as the more stringent requirements anticipated for the future. An effective membrane filtration process combines a basic understanding of the wastewater chemistry with innovative high-flux membranes. The membrane provides a positive barrier against all particulate matter while delivering a consistently high flow rate of clean effluent. Uses for low-level radioactive wastewater are also discussed. (Baker-IVI)
W85-05770

ELECTROCHEMICAL GENERATION OF HIGH-CONCENTRATION OZONE FOR WASTE TREATMENT,
Oxy-Tech, Inc., Berkeley, CA.
P. C. Foller, and M. L. Goodwin.
Chemical Engineering Progress, Vol. 81, No. 3, p 49-51, March, 1985. 1 Fig, 1 Tab, 7 Ref.

Descriptors: *Wastewater treatment, *Ozone, *Electrochemical generation, Disinfection, Chemical reactions, Oxidation, Kinetics.

The variety of aqueous chemical waste streams that may be treated by ozone, which is generally recognized to be environmentally advantageous, may increase substantially with the advent of electrochemical generation technology. Research and development leading towards field tests of the technology and its eventual commercial availability will be continuing. Electrochemical ozone generation has commercial potential in small scale waste treatments, in which the administration of hypochlorite based oxidants is not effective enough, leads to high operating costs, or is environmentaly disadvantageous. Two reasonably attractive ways in which ozone has been electrochemically generated are considered. Oxidation kinetics involved in the use of ozone for wastewater treatment are delineated. (Baker-IVI)
W85-05771

WET OXIDATION FOR INDUSTRIAL WASTE TREATMENT,
Michigan Technological Univ., Houghton.
C. R. Baillod, R. A. Lamparter, and F. A. Barna.
Chemical Engineering Progress, Vol. 81, No. 3, p 52-56, March, 1985. 7 Fig, 4 Tab, 6 Ref.

Descriptors: *Wastewater treatment, *Chemical oxygen demand, *Economic aspects, *Wet oxidation, Temperature effects, Biological wastewater treatment.

For those wastes that are not acceptable at a biological treatment facility, and the alternative method of disposal is hauling as a hazardous waste under the Resource Recovery and Conservation Act regulations, wet oxidation is an economically attractive method of treatment in reducing oxygen demand and altering the biotreatability. In the case of a biotreatable waste, the economic picture is reversed. Further, while biological treatment charges are based on chemical oxygen demand, the cost of wet oxidation is not much greater than typical municipal or industrial charges. Equipment selection and cost factors are given for compressor, feed pump, preheater heat exchanger, reactor, and steam generator. A summary of the cost of major purchased equipment items is given. (Baker-IVI)
W85-05772

EFFLUENT REUSE IN SOUTHEAST FLORIDA.
Biocycle, Vol. 26, No. 2, p 39-40, March, 1985. 3 Fig.

Descriptors: *Wastewater-irrigation, *Water reuse, *Florida, Effluents, Infiltration, Water supply development, Water resources development, Overland flow, Runoff.

In South Florida the practice of using reclaimed wastewater as a substitute for former potable water uses is rapidly becoming a necessary option as potable groundwater resources are limited. Potential users of reclaimed wastewater such as managers of golf courses and parks have requested water management, health and environmental agencies to closely examine the feasibility of such reuse with particular attention given to slow rate irrigation, overland flow, and high rate infiltration. For slow rate irrigation the effluent may be applied by either surface or sprinkler techniques. Application rates range between one and four inches per week. A two inch/week application rate is typical and recommended as a general guideline. Overland flow treatment systems generally include a holding pond for storage during adverse conditions, or an alternate disposal system. Wastewater is applied by sprinkling or flooding upper reaches of terraced, sloped, vegetated surfaces such as sod farms, forests, fodder crops, or pastures. This method is used on soils with low infiltration capacity and high runoff potential, due either to high clay content or restrictive layers. High rate infiltration requires a high hydraulic capacity with application rates being usually one to ten inches per day. (Baker-IVI)
W85-05776

ADVANCED WATER RECYCLING SYSTEM REQUIRED FOR NEW SOUTH AFRICAN MILL,
Main (Charles T.), Inc., Boston, MA.
For primary bibliographic entry see Field 3C.
W85-05777

OZONE ENHANCED BIOLOGICAL ACTIVATED CARBON IN DENVER, COLORADO: A PILOT PLANT STUDY,
Arber (Richard P.) Associates, Inc., Denver, CO.
W. F. Lorenz, K. D. Linstedt, and E. R. Bennet.
Ozone: Science and Engineering, Vol. 6, No. 2, p 71-86, 1984. 10 Fig, 7 Tab, 7 Ref.

Descriptors: *Activated carbon, *Ozonation, *Wastewater treatment, *Water treatment, *Denver, *Colorado, Aeration, Total organic carbon, Ammonium, Oraganic carbon.

Results of research into wastewater renovation have been incorporated into a 3785 cu m/day demonstration plant for assessing the practicality of producing potable water from wastewater treatment plant effluent. The pilot study was performed to determine if ozone addition in conjuction with carbon contacting would be likely to result in enhanced activated carbon performance in the demonstration plant. Five parallel ozone and activated carbon systems were compared for their effectiveness in treating unchlorinated effluent from a wastewater facility. Data were gathered over four months of continuous operation. The five treatment trains included 1) air/carbon (aeration prior to activated carbon contact), 2) ozone/carbon with 5 mg/l of applied ozone, 3) ozone/carbon with 15 mg/l of applied ozone, 4) ozone/carbon with 30 mg/l of applied ozone, and 5) carbon/ozone/carbon incorporating carbon contact prior to and following 15 mg/l of applied ozone. The initial carbon contact in the carbon/ozone/carbon also served as a control in the study. Ozone treatment followed by carbon contacting demonstrated improved TOC removal over treatment by air/carbon or carbon alone. Maximum TOC removals after ozone and 15 minutes of carbon contact were 57% greater than those for carbon without preozonation. Carbon/ozone/carbon treatment consistently reduced effluent TOC concentrations to levels of less than 0.5 mg/l, with represented greater than 92% TOC removal. Ammonium ion removals of 65 to 70% were achieved after 15 minutes of GAC contact in the preaerated and preozonated systems. The removal was independent of ozone dose. (Collier-IVI)
W85-05826

OZONE DISINFECTION DESIGN AND OPERATION CONSIDERATIONS,
Process Applications, Inc., Fort Collins, CO.
K. L. Rakness, and B. A. Hegg.
Ozone: Science and Engineering, Vol. 6, No. 2, p 87-102, 1984. 7 Fig, 5 Tab, 12 Ref.

Descriptors: *Ozonation, *Disinfection, *Wastewater treatment, Design criteria, Operating costs, Energy, Water treatment.

Wastewater ozone disinfection systems can perform well if attention is given to critical design and operational factors. For example, a continuous dew-point of -60 C is recommended. Equipment duplication, system flexibility, and dew-point monitoring with alarms are also recommended. Variable energy consumption for producing ozone is typically available within the generation equipment. Variability in the energy consumption of the feed-gas supply and pretreatment systems should also be provided. Improper contact basin design can cause a significant increase in ozone dosage needed to achieve a given level of disinfection. Ozone transfer efficiency, mixing and short-circuiting are factors affecting performance. Fine bubble diffuser contacting systems with 5-7m deep basins and with multiple, vertical stages represent a good design condition. Other important design and operation considerations include providing ozone destruct equipment, welded stainless steel piping, and isolated location, monitoring equipment, control equipment, and operator training. (Author's abstract)
W85-05827

OZONATION OF AQUEOUS SOLUTIONS OF NITROBENZENE,
Naples Univ. (Italy). Ist. di Chimica Industriale e Impianti Chemici.
V. Caprio, A. Insola, and G. Volpicelli.
Ozone: Science and Engineering, Vol. 6, No. 2, p 115-121, 1984. 5 Fig, 9 Ref.

Descriptors: *Ozonation, *Nitrobenzene, *Wastewater treatment, *Chemical reactions, Oxidation, Oxalic acid, Water treatment.

The ozonation of nitrobenzene in aqueous solution was investigated by determining COD removal, ozone consumption and product distribution at different degrees of ozonation. Results reveal that complete nitrobenzene elimination is achieved at relatively short ozonation times, with no appreciable accumulation of unsaturated intermediates. Oxidative consumption of about 2.5 oxygen atoms per mole of absorbed ozone was observed in this ozonation stage. Much longer ozonation times are required to reach complete oxidation of intermediates to oxalic acid and carbon dioxide, with an oxidative consumption corresponding to 1.8 oxygen atoms per mole of absorbed ozone. A reaction scheme was proposed on the basis of the observed product distribution. (Author's abstract)
W85-05829

EWTUS IN CHINA,
W. Baozhen.
Effluent and Water Treatment Journal, Vol. 25, No. 2, p 43-55, February, 1985. 12 Fig, 3 Tab, 14 Ref.

Descriptors: *Developing countries, *China, *Wastewater treatment, Biological wastewater treatment, Ponds, Aquaculture, Aquatic plants, Costs, Aquatic ecosystems.

It is estimated that the municipal wastewater treatment plants in China total about forty in number with total treatment capacity of one million cu m per day, which is less than 2% of the total daily discharge of municipal wastewater throughout the country. As a developing country, China cannot make the huge investment needed to construct the large number of conventional secondary wastewater treatment plants. Neither can it operate these plants due to lack of finances, energy and skilled operating personnel. Thus the strategy for wastewater treatment in China has to be to put stress on the development of innovative and alternative treatment techniques instead of conventional ones. Quite a few Chinese cities have treated wastewaters through the use of fish farming ponds. Hydrophyte ponds have also been used in which aquatic plants are grown to purify wastewater and then harvested as feed for poultry and pigs as well as aquatic vegetables for human beings. In ecosystem ponds the incoming wastewater is treated and used by ecological systems established artificially or semi-artificially. These systems in combination with primary conventional treatment have many advantages, such as low capital cost and low operation and maintenance costs, and huge profit potential. Two types of systems are taken as examples for cost and profilt analysis: the primary treatment facilities to the fish pond system, and the primary treatment facilities to the ecoponds to the irrigation field system. (Baker-IVI)
W85-05834

USSR RUNOFF TREATMENT,
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Vodosnabzheniya, Kanalizatsii, Gidrotekhnicheskikh Sooruzhenii i Inzhenernoi Gidrogeologii, Moscow (USSR).
A. P. Nechaev.
Effluent and Water Treatment Journal, Vol. 25, No. 2, p 57-59, February, 1985. 3 Fig, 1 Tab.

Descriptors: *Wastewater treatment, *Storm runoff, *USSR, Runoff, Organic compounds, Minerals, Salts, Chemical analysis, Urban runoff, Settling ponds.

Runoff generated as a result of precipitation, snow melting, washing and water flushing within municipal and industrial territories is one of the sources of water pollution. The damage caused to water bodies is by periodic momentary discharges of great amounts of contaminants contained in rain runoff - often considerably exceeding the self-purifying ability of the receiving water bodies. Calculations in the USSR show that during the first hour of rainfall about 200 kg of undissolved impurities, up to 20 kg of oil products and up to 50 kg of organic compounds may be washed away from 1 ha of urban territory. The decrease of contaminants drained from industries is of utmost significance in the runoff treatment problem. Measures to reduce contamination include: control of storage and transportation of raw materials, intermediate products and industrial wastes; elimination of industrial waste discharge including spent oil products to the storm sewerage system; increase in operation efficiency of dust and gas treatment plants; and the organizing of regular mechanized disposal from industries. Various types of settling tanks are used on large scale for the treatment of runoff in the USSR. As the runoff is characterized by relatively low mineral salt content and organic impurities content it seems to be expedient to use it for industrial water supply purposes. (Baker-IVI)
W85-05835

5E. Ultimate Disposal Of Wastes

CHICAGO EXPERIENCE IN LARGE-SCALE LAND APPLICATION,
Metropolitan Sanitary District of Greater Chicago, IL.
G. W. Hall, J. C. Moore, III, and T. S. Skuse.
BioCycle, Vol. 26, No. 1, p 38-44, January/February, 1985. 5 Fig, 4 Tab.

Descriptors: *Sludge application, *Waste disposal, *Land disposal, *Chicago, *Illinois, Prairie Plan, Land reclamation, Strip mines, Municipal wastes, Recreation, Conservation, Costs.

The Metropolitan Sanitary District of Greater Chicago and Fulton County together developed a program, the Prairie Plan, to deal with the problems of sewage solids utilization for the city and strip-mined land reclamation for the county. In October of 1970 the Metropolitan Sanitary District of Greater Chicago purchased 7,156 acres of land in Fulton County. The site is located about 90 miles southwest of Chicago. The Prairie Plan is a large scale recycling program which provides benefits to both parties, including a safe, cost effective method for disposition of sewage solids, restoration of strip-mined lands to productive use, and provides recreation, conservation and wildlife preservation areas. Several awards have been given to the project. Effective management has enabled the plan to respond and adjust to changing requirements. The plan from 1970 through 1982 has cost $126.4 million: in land - $5.9 million, capital facilities - $33.3 million; application and other costs - $32.8 million, and transportation - $60.2 million. By the end of 1982 there remained an undepreciated value of $17.2 million for capital facilities. (Baker-IVI)
W85-05058

MUNICIPAL WASTEWATER INCREASES CROP YIELDS,
Arizona Water Resources Research Center, Tucson.
For primary bibliographic entry see Field 3C.
W85-05059

PROCESS DESIGN MANUAL FOR LAND APPLICATION OF MUNICIPAL SLUDGE,
SCS Engineers, Inc., Long Beach, CA.
For primary bibliographic entry see Field 5D.
W85-05127

DESIGN MANUAL, MUNICIPAL WASTEWATER STABILIZATION PONDS,
Clemson Univ., SC.
For primary bibliographic entry see Field 5D.
W85-05133

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON NEW TECHNOLOGY FOR WASTEWATER TREATMENT AND SEWERAGE IN RURAL AND SUBURB AREAS.
Tampere Univ. of Technology (Finland). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W85-05195

POLICY AND REGULATIONS IN SCANDINAVIA,
National Board of Waters, Helsinki (Finland). Office for Water Supply and Sewerage.
For primary bibliographic entry see Field 5D.
W85-05197

PRINCIPLES OF COMPOSTING,
Helsinki Univ. (Finland). Dept. of Microbiology.
M. Salkinoja-Salonen.
In: Proceedings of the International Conference on New Technology for Wastewater Treatment and Sewerage in Rural and Suburb Areas, Hanasaari, Finland, October 3-6, 1983. Tampere Univ. of Technology, Finland. 1984. p 177-189, 1 Fig, 7 Tab, 21 Ref.

Descriptors: *Waste disposal, *Solid waste disposal, *Composting, *Microbial degradation, *Pathogens, *Land disposal, *Biodegradation, Wastewater treatment, Wastewater disposal, Streptococcus, Soil amendments, Domestic wastes, Feces, Heavy metals, Separation techniques, Heavy metals, Organic compounds, Organic wastes, Wastes, Landfills, Scandinavia.

Of the solid refuse produced in 1981 in Helsinki, 79% of household and business refuse was suitable for composting. Composting is a process where microorganisms oxidize the major part of the organic matter into CO2, H2O and inorganic salts, and a lesser part into microbial biomass and stable organic matter known as humus. For composted refuse to have a positive market value, it must have nutrient value to plants, not contain materials toxic to plants or animals and be safe from the hygienic point of view. The presence of thermostabile coliform bacterial or fecal streptococci is considered indicative of fecal contamination. Fecal bacteria were reduced to 1/1000 or less in a household waste compost in Helsinki. Various studies showed that the destruction of bacteria in compost piles was not temperature dependent. The destruction of poliovirus which was complete after 8 days of composting was also not temperature related. Heavy metals are not removed by composting. In the Netherlands, plastic, glass and metals are removed from the compost by blowing or screening. Use of compost in Sweden is confined to landfills. In Helsinki, compost prepared from sorted wastes was low in heavy metals and rich in trace elements such as Se. The composting of hazardous wastes such as oil, pesticides and TNT contaminated materials is still being investigated and shows promise for waste treatment.
W85-05206

TESTING OF BIOLOGICAL (COMPOSTING) TOILETS AND PRACTICAL EXPERIENCES IN NORWAY,
Norges Landbrukshoegskole, Aas. Inst. for Georesources and Pollution Research.
For primary bibliographic entry see Field 5D.
W85-05207

BARK CHIP DECOMPOSITION LATRINES,
Kymi Provincial Environmental Conservation Bureau, Kouvola (Finland).
For primary bibliographic entry see Field 5D.
W85-05208

LAND TREATMENT OF MUNICIPAL WASTEWATER: SELECTED EXAMPLES IN THE UNITED STATES,
Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 5D.
W85-05324

TOLUENE, ENVIRONMENTAL AND TECHNICAL INFORMATION FOR PROBLEM SPILLS.
Environmental Protection Service, Ottawa (Ontario).
March 1984. 104 p, 29 Fig, 8 Tab, 208 Ref.

Descriptors: *Toluene, *Hydrocarbons, *Spill control, *Water pollution control, Aquatic life, Hazardous materials, Toxicity, Waterfowl, Skimming, *Toxic wastes.

Toluene is a colorless, watery liquid with an aromatic odor. Its synonyms include Toluol, Methylbenzene, and Phenylmethane. Toluene is a flammable liquid. Vapor forms explosive mixtures with air and flashback may occur along the vapor trail. For humans, toluene is toxic via inhalation, ingestion, and skin contact. Toluene is toxic to aquatic life. It may be hazardous to waterfowl and animals through ingestion or contact. Toluene has no food chain concentration potential. It is harmful to some species at concentrations as low as 10 mg/l. For spill control, access to the spill site needs to be restricted. The warning of flammable needs to be issued and the fire department and manufacturer have to be notified. Sources of ignition including traffic and equipment have to be eliminated. The flow has to be stopped and the spill contained. Contact with liquid and vapor should be avoided. The contaminated water has to be kept from entering sewers or watercourses. Emergency control procedures on water include: contain with booms, weirs or natural barriers. Use (oil) skimming equipment or suction hoses to remove slick, followed by the application of sorbents. All equipment should be spark- or explosion-proof.
W85-05336

FIFTH ANNUAL MADISON CONFERENCE OF APPLIED RESEARCH AND PRACTICE ON MUNICIPAL AND INDUSTRIAL WASTE.

Wisconsin Univ.-Extension, Madison. Dept. of Engineering and Applied Science.
For primary bibliographic entry see Field 5D.
W85-05364

CASE STUDY OF LEACHATE AND GAS MANAGEMENT AT A SANITARY LANDFILL,
Reitz and Jens, Inc., St. Louis, MO.
For primary bibliographic entry see Field 5D.
W85-05365

CHOOSING SEWAGE ASH DISPOSAL SITES IN THE TWIN CITIES METROPOLITAN AREA,
Metropolitan Council, St. Paul, MN.
For primary bibliographic entry see Field 5D.
W85-05366

DEVELOPMENT OF A SLUDGE/REFUSE CO-DISPOSAL PROGRAM,
Donohue and Associates, Inc., Sheboygan, WI.
J. W. Garvin, L. N. Hicks, and J. C. Batzner.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 101-108, 2 Tab.

Descriptors: *Co-disposal of wastes, *Solid waste disposal, *Sludge disposal, *Industrial wastes, *Sanitary landfills, *Waste management, *Wastewater treatment, *Wastewater disposal, Waste recovery, Waste characteristics, Waste disposal, Landfills, Odor, Sludge, Sludge thickening, Pulp and paper industry, Sludge drying, Sludge solids, Wisconsin.

The sludge/refuse co-disposal program was developed in 1979 for the Outagamie County, Wisconsin sanitary landfill in response to a need to dispose of waste sludge from the Midtec paper mill operation. During the development of the sludge handling program, various combinations of excavated trenches and co-mixing with refuse materials were attempted. Prior to the selection of co-disposal as a waste-management technique, feasibility evaluations of waste types, quantities and availability were carried out. An analysis of alternatives for implementation of a co-disposal program must also be considered. These criteria include regulatory guidelines, receiving site design, receiving site operations, on-site mixing of waste types, and other handling methods such as trench or lagoon filling operations or intermediate dewatering and composting to accomodate operational conditions. Some advantages of co-disposal are its low cost, environmental acceptability, ease of implementation and operation and potential for methane gas recovery. Some major disadvantages of co-disposal are its sensitivity to weather changes, dependent upon strict schedules for waste delivery, odor, and inability to adjust to variations in sludge water content.
W85-05367

RED HILL DISPOSAL SITE: A CASE STUDY,
Brown, Vence and Associates, San Francisco, CA.
K. Runyon, R. C. Slade, and C. R. Leitzell.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 129-145, 3 Fig, 1 Tab, 7 Ref.

Descriptors: *Case studies, *Groundwater pollution, *Landfills, *Water pollution control, *Waste disposal, *Water quality control, *Leaching, Land disposal, Leachates, Surface-groundwater relations, Surface water, Conductivity, Water quality, Waste recycling, Wastewater management, Water pollution sources, Fate of pollutants, Path of pollutants, Membranes, Waste management, California.

A case study of groundwater and surface water contamination problems at the Red Hill Disposal Site landfill located in Calaveras County, California is presented. Since landfilling began at the Red Hill site in 1975, the County Department of Public Works has collected water samples on a quarterly basis. Water samples taken from Canyon A showed a gradual increase in conductivity from 1975 to 1978 and hence a decline in water quality. Conductivity declined in early 1979 after the installation of the cutoff dam and drain in the upper portion of Canyon A. This decrease in conductivity also reflects dilution effects resulting from three seasons of abnormally heavy rainfall subsequent to drought years. The annual percentage increase in refuse delivered to Red Hill is expected to remain below 10%. To protect groundwater from leachate in Canyons A and B, several measures were planned which included application of a clay liner to Canyon A, excavation of the hilltop in Canyon B, application of a membrane liner to Canyon B, modification of the leachate handling system, continuing the program for buying back reusable wastes, and obtaining equipment and approvals for brush burning.
W85-05368

INVESTIGATIONS OF LEACHATE CONTAMINATION OF GROUND AND SURFACE WATERS AT THE FRESH KILLS LANDFILL, NEW YORK CITY,
For primary bibliographic entry see Field 5B.
W85-05369

LEACHING BEHAVIOR OF LEAD AND CADMIUM AT VARIOUS PH CONDITIONS,
Residuals Management Technology, Inc., Madison, WI.
D. L. Nagle, T. P. Kunes, and R. R. Stanforth.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 210-224, 3 Fig, 3 Tab, 11 Ref.

Descriptors: *Heavy metals, *Leachates, *Landfills, *Metal-finishing wastes, *Hydrogen ion concentration, *Hazardous materials, *Waste characteristics, *Waste identification, Leaching, Metals, Waste dumps, Municipal wastes, Lead, Cadmium, Waste disposal, Wastewater disposal, Land disposal, Waste management.

The standard USEPA EP leaching test procedure for determining whether a waste is hazardous requires that a waste sample be leached in a pH 5.0 +/- 0.2 acetic acid leaching solution for 24 or 28 hr. A waste is classified as hazardous if toxic metals are released in concentrations greater than 100 times the National Interim Primary Drinking Water Standards. The pH 5 value was selected, in part, to represent pH conditions at an actively decomposing municipal waste landfill. To evaluate the pH dependence on leaching of lead and cadmium from foundry wastes, four samples of ferrous foundry emission control residuals and one sample of brass foundry sand were leached using the USEPA leaching procedure with pH values ranging from 4.2 to 8.8. Results showed that, in all cases, the leachate concentration of lead and cadmium increased as the leachate pH decreased, sometimes as much as an order of magnitude over the range of a pH unit. Within EPA's acceptable range of 4.8 to 5.2, test results can show a waste to be hazardous at pH 4.8 and nonhazardous at 5.2. These data also show that landfill pH conditions are important in the selection and design of a disposal system and are essential in developing the degree of hazard criteria currently being considered by the USEPA. (Author's abstract)
W85-05370

CHEMICAL CHARACTERISTICS OF LEACHATE FROM MUNICIPAL SOLID WASTE LANDFILLS IN WISCONSON,
Wisconsin Dept. of Natural Resources, Madison. Bureau of Solid Waste Management.
P. Kmet, and P. M. McGinley.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 225-254, 31 Fig, 5 Tab, 13 Ref.

Descriptors: *Leachates, *Landfills, *Solid wastes, *Waste characteristics, *Waste identification, *Solid waste disposal, *Municipal wastes, *Groundwater pollution, Waste disposal, Leaching, Waste management, Wastewater treatment, Municipal wastewater, Wastewater analysis, Organic compounds.

Leachate quality data from 16 active municipal solid waste landfills, some of which have practiced co-disposal of hazardous wastes was compiled and analyzed. Analysis of pH, suspended solids, specific conductance, biological oxygen demand, chemical oxygen demand, hardness, alkalinity, sulfates, chlorides, numerous metals and priority pollutants confirms that leachates are contaminated to a strength greater than or equal to that of municipal wastewater for most parameters measured. Several contaminants in particularly Fe and total dissolved solids exceeded drinking water standards. In general, leachates were slightly acidic with a very high organic and dissolved solids concentration. Lesser, but still substantial quantities of total kjeldahl N, hardness, alkalinity, chlorides and sulfate were also present. Examinations of 5 municipal waste dump leachates for 114 priority pollutant organics revealed the presence of 36 of these compounds in leachate samples. All municipal solid waste leachate currently generated in Wisconsin is treated at existing municipal wastewater treatment plants. Close monitoring of leachate chemical characteristics is desirable to prevent treatment plant upset.
W85-05371

ANALYSIS OF UNDERDRAIN FOR WASTE DISPOSAL LEACHATE,
Golder Associates, Atlanta, GA.
J. F. Clerici, and G. H. Collison.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 255-271, 7 Fig, 1 Tab, 5 Ref.

Descriptors: *Leachates, *Linings, *Subsurface drainage, *Drainage systems, *Drains, *Subsurface drains, Leaching, Drainage patterns, Waste disposal, Landfills, Waste dumps, Seepage.

A simple method was devised to evaluate various underdrain system alternatives for waste disposal leachate control. The method assumes that the lateral flow gradient in the underdrain is equal to the slope of the bottom of the underdrain. The method was applied to the analysis of a nominal 40 ha pond for a blanket, pipe, and combination pipe and blanket underdrain system. Results indicated that a two layer blanket underdrain is the most feasible system. A coarse bottom drain layer with a filter material layer between it and the tailings appears to be the most functional design. A 2% bottom slope is considered a minimum. Significant reductions in the saturated drain thickness and seepage can be achieved by placing the collection system around the perimeter of the pond bottom. Efficiency studies of the proposed underdrain system showed that, for a wide range of drain permeabilities, the thickness of the liner does not substantially affect the rate of pond seepage. The effect of increasing the drain layer permeability one order of magnitude higher than the design value will not significantly reduce the estimated pond seepage rate.
W85-05372

LEACHATE DISPOSAL ALTERNATIVES IN A SOLE SOURCE AQUIFER ENVIRONMENT,
Dvirka and Bartillucci, Syosset, NY.
J. D. Cameron, and M. W. Stewart.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison, p 272-293, 2 Tab, 44 Ref.

Descriptors: *Leachates, *Waste disposal, *Wastewater disposal, *Wastewater treatment, *Waste recycling, *Sanitary landfills, *Groundwater pollution, *Waste characteristics, *Cost analysis, Leaching, Wastewater renovation, Landfills, Linings, Aquifers, Liquid wastes, Waste dumps, Wastewater analysis, Wastewater collection, Land disposal, Aquaculture, New York.

When an area is dependent upon aquifers as its sole source of potable water supply, special efforts must be made to prevent contamination of groundwater by landfill leachate. Consistent with this effort is the installation of impermeable liners beneath sanitary landfills to prevent groundwater contamination from leachate flows and the use of appropiate measures for collected leachates. Three alternatives to the leachate waste disposal problems of the Brookhaven, N.Y. sanitary landfill were examined. These included conventional treatment with discharge to surface or groundwater, transport of wastes to the wastewater treatment plant, and an aquaculture system. A detailed study of the leachate characteristics was made prior to the testing of disposal options. Those alternatives that did not involve a groundwater discharge were considered more favorable than those that did. Economically, transporting of wastes was feasible in the short term, but would prove to be expensive in the long term if fuel costs increase. Aquaculture did not prove to be a viable alternative since long periods of freezing might pose problems. A waste recycling plan was considered to hold promise for the future but required further development for large scale operation. It was recommended that the Brookhaven landfill adopt a plan to transport its leachates by truck to the County's major wastewater treatment facility while continuing to pursue a more cost-effective solution.
W85-05373

USE OF AQUACULTURE FOR THE TREATMENT OF LANDFILL LEACHATE IN COLD CLIMATES,
Anderson-Nichols and Co., Inc., Boston, MA.
M. A. Sills, and J. J. Struzziery.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 294-300, 3 Fig, 1 Tab, 5 Ref.

Descriptors: *Landfills, *Wastewater treatment, *Wastewater renovation, *Aquaculture, *Algae, *Duckweed, *Leachates, *Cold regions, Waste recycling, Design criteria, Cost analysis, Air temperature, Planning, Wastewater composition, Waste characteristics.

The planning, design and operational considerations used in the selection of aquaculture leachate treatment systems for landfills in Fitchburg, Massachusetts and Nashua, New Hampshire are described. The key planning and design variables for such systems were found to be the performance objectives of the treatment units, the annual average air temperature, the quantity of leachate generated, the toxicity and treatability of the leachate, the specific types of aquaculture species to be used, the process related environmental conditions of the land, and cost considerations. An accurate determination of leachate flow rates and quality and treatability are also important factors in the aquaculture system. For the Fitchburg landfill, the aquaculture leachate system is composed of a two cell shallow, lined duckweed pond followed by overland flow through a wetland and discharge to a stream. The Nashua system includes chemical precipitation followed by a three cell aerobic facultative algae lagoon with discharge to the city sewerage sytem. The duckweed treatment system provides a fairly high quality effluent with low energy and land requirements for relatively low leachate flow rates while the mechanically aerated algae lagoon system provides variable degrees of treatment efficiences for much higher flow rates and is generally more flexible to effluent limitations and land area constraints.
W85-05374

'CONTAINMENT' STRATEGIES TO MANAGE ABANDONED HAZARDOUS WASTE SITES IN A COST EFFECTIVE MANNER,
Weston Environmental Consultants-Designers, West Chester, PA.
J. W. Thorsen.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 314-329, 4 Fig, 1 Tab, 7 Ref.

Descriptors: *Waste management, *Water pollution control, *Wastewater treatment, *Waste storage, *Waste treatment, *Waste disposal, *Leachates, *Hazardous materials, Groundwater pollution, Wastewater management, Groundwater management, Leaching, Liquid wastes, Waste dumps, Chemical treatment, Toxic wastes.

The potential components of waste containment strategies that may be used at different types of hazardous waste storage sites include waste management, surface management and groundwater management. The three basic waste management components that may be required to implement the waste containment strategy are dewatering the wastes, stabilization/fixation/conditioning the wastes and the use of geotextile fabrics. The key factors to determine rates and quantities of liquids that may be removed from the waste mass area are the transmisitivity of the waste mass, the percent liquids in the waste mass, the particle size and the chemical composition. The two primary control mechanisms to provide for surface protection of the waste mass in the waste containment strategy are the placement of covers and cap systems and the provision for run-on and run-off controls. The basic classes of covers that may be used are multilayer systems, asphaltics, concrete, synthetics, natural soils, and soil admixtures. Run-on and run-off controls are important to minimize the amount of water reaching the waste mass. Groundwater controls to aid waste containment strategies include flow diversion (passive controls), flow manipulation (active controls) and groundwater treatment by destruction of toxic wastes, volume reduction of toxic wastes or stabilization of hazardous materials.
W85-05375

FINDING AN ACCEPTABLE APPROACH FOR DISPOSAL OF COAL COMBUSTION RESIDUES IN CALIFORNIA,
Stanley Consultants, Inc., Muscatine, IA.
M. N. Macaulay, and E. R. Slattery.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 330-343, 8 Fig, 1 Tab, 10 Ref.

Descriptors: *Hazardous materials, *Waste disposal, *Fly ash, *Waste characteristics, *Leachates, *Waste recycling, *Landfill, *Waste management, *Pilot plants, Water quality, Wastewater treatment, Land disposal, Waste dumps, Regulations, California.

The Department of the Navy proposes to convert spreader stoker boilers from fuel oil to low sulfur western coal at the MINSY boiler plant, Vallejo, California. Flue gas cleaning (FGC) waste and bottom ash will be produced from the converted boilers. The FGC waste system will be captured in bag houses and will consist of fly ash, reaction products of desulfurization and excess lime. The bottom ash will be collected in underground hoppers. Laboratory characterization of waste samples approximating the waste to be produced by the MINSY boiler conversion project showed that the material will not be considered hazardous according to federal criteria but will be considered hazardous according to leachate testing criteria established by the state of California for Cd, Cu and Zn. The physical properties of the conditioned wastes will be enhanced by bottom ash additions. Marketing of the FGC waste should be pursued as a method of reducing the quantity of waste directed to the landfill. A long-term disposal system should not be planned and constructed until after sufficient water quality data is collected from a specially designed short-term disposal system. Following completion of a short-term demonstration project, an agency review of water quality data will provide a basis for issuance of final long-term disposal requirements at the designated landfill site on Mare Island.
W85-05376

FIELD INVESTIGATION AND REMEDIAL ACTION AT A SITE CONTAMINATED WITH COAL TARS,
TRC Environmental Consultants, Inc., East Hartford, CT.
D. F. Unites, and J. J. Housman, Jr.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 344-354, 4 Fig, 4 Tab, 4 Ref.

Descriptors: *Groundwater pollution, *Water pollution control, *Waste disposal, *Coal gasification, *Organic compounds, *Organic wastes, *Waste recycling, Boreholes, *Wastewater treatment, Waste dumps, Coal, Organic compounds, Hydrocarbons, Phenols, Industrial wastes, Recycling, Tar, Water pollution, Pennsylvania, Test holes.

Beginning in the early 1800's and continuing into the first half of the twentieth century, literally hundreds of privately operated coal gasification works served the coal gas needs of growing municipalities and industries across the United States. By the end of World War II, gas lighting had become virtually extinct. For the gas fuel market that remained, the small coal gasification plants could not complete with cheaper pipeline natural gas supplied by the large gas companies. As a result, small gasification works were rapidly forced out of business. Plants were dismantled and properties sold. Quickly forgotten were the coal tar residues generated and often discarded at or near these locations. Depending on the disposal methods and site geology, these sites can present an environmental hazard even after 30 years of inactivity. The main hazards are groundwater contamination by phenols and aromatic hydrocarbons and direct skin contact with the tars. Remedial actions a coal gasification sites may include removal of the material, containment or a combination of these. At a site in Stroudsburg, Pennsylvania, geologic conditions were such that containment and pumping removal were the most cost effective alternatives. High costs of treating contaminated ground water were eliminated and the recovered tar was able to be sold. (Author's abstract)
W85-05377

IMPACT OF SEWERAGE IRRIGATION ON THE CHEMISTRY OF GROUND AND SURFACE WATERS,
Kentucky Geological Survey, Lexington.
M. A. Townsend.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 364-379, 6 Fig, 3 Tab, 10 Ref.

Descriptors: *Wastewater disposal, *Wastewater renovation, *Land disposal, *Path of pollutants, *Wastewater irrigation, *Spray irrigation, *Groundwater pollution, *Groundwater recharge, Hydrogeology, Sodium, Chlorine, Sulfates, Nitrate, Fate of pollutants, Water pollution sources, Liquid wastes, Ions.

A study was made of the hydrogeology and effects of sewage spray irrigation at the 135-acre Kerrville, Texas site. In addition the chemical changes in waste water as it percolates through the soil were investigated. Secondarily treated effluent (a sodium-bicarbonate-chloride water) is sprayed on the land surface at an average rate of 8.0 cm/wk. Results showed that the Na, Cl, and sulfate levels were unaffected as the wastewater percolated

through the alluvium and moved across the site within the gravel stratum. However, the concentrations of ammonia, nitrate, and phosphate decreased. A 40 to 60% increase in Na, Cl, and sulfate was noted in Third Creek, a stream that traverses the study area indicating recharge of the stream by groundwater from the irrigation site. The marked decrease in concentration of Na, Cl, and sulfate between 1965 and 1980 indicates that the installation of an oxidation ditch and spray irrigation system at the site has improved the quality of both the irrigation water and Third Creek. Discharge measurements indicate a 65 to 80% increase in flow of Third Creek through the study area. Mass balance of dissolved ions showed that an additional source of more dilute groundwater recharges the creek.
W85-05378

GEOHYDROLOGIC MODELLING FOR INDUSTRIAL WASTE DISPOSAL SITE EVALUATION,
Golder Associates, Atlanta, GA.
For primary bibliographic entry see Field 5B.
W85-05379

FIELD INVESTIGATION OF A SUPERFUND SITE,
Residuals Management Technology, Inc., Madison, WI.
D. G. Nichols.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September, 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 404-420, 2 Fig, 5 Tab, 7 Ref.

Descriptors: *Waste disposal, *Land disposal, *Groundwater pollution, *Organic compounds, *Path of pollutants, *Waste dumps, *Organic solvents, *Test wells, Landfills, Aquifers, Organic wastes, Hazardous materials, Solvents, Water quality, Boreholes, Fate of pollutants, Carcinogens.

A 200 acre area disposal site for solvents, inks and other hazardous wastes was studied to determine its effects on groundwater quality. The site is located west of Minneapolis in an area of coarse grained glacial soils that are used locally as an aquifer. The field investigation involved the installation of ten borings, 24 wells, and several water stations. Results showed that shallow groundwater throughout the area is contaminated primarily with organics and that the pollution has spread throughout much of the soil column. Two carcinogens (tetrachloroethylene and anthracene) were found in high concentrations. The soil layer that is used as an aquifer may also be threatened. More work is needed to determine the degree of contamination of site, and the need for treatment of surface water and soils, and which areas of the site must be closed.
W85-05380

EFFECT OF SLUDGE QUALITY AND RATE, SOIL PH, AND TIME ON HEAVY METAL RESIDUES IN LEAFY VEGETABLES,
Agricultural Research Service, Beltsville, MD. Biological Waste Management and Organic Resources Lab.
R. L. Chaney, S. B. Sterrett, M. C. Morella, and C. A. Lloyd.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI. September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 444-458, 1 Fig, 5 Tab, 21 Ref.

Descriptors: *Land application, *Heavy metals, *Cadmium, *Sludge, *Solid waste disposal, *Soil amendments, Absorption, *Vegetable crops, Waste disposal, Hydrogen ion concentration, Crops, Agriculture, Zinc, Metals, Lettuce, Collards, Chard.

Romaine lettuce, chard, and collards were grown on field plots to evaluate crop uptake of Cd as affected by sludge Cd concentration, application rate, soil pH, and time since application. Cd concentrations in crops grown on calcareous, low Cd sludge plots were similar to unamended controls. Acidic heat-treated sludge plots, and both acidic and limed Nu-Earth plots caused significant increase in lettuce Cd. Foliar Cd was increased by the lowest rate of these sludges, but higher rates caused only small further increase in lettuce Cd (at both pH levels). These results indicate a substantial influence of sludge Cd concentration on Cd uptake by crops, suggesting that sludge also supplied Cd-adsorption capacity to the soil. Sludge-applied Cd remained crop available for the 6 years studied. In contrast with lettuce and chard which accumulated high levels of Zn and Cd, collards were only slightly higher in Cd even on acidic Nu-Earth plots. (Author's abstract)
W85-05382

NATURAL BUFFERS FOR SLUDGE LEACHATE STABILIZATION,
Dames and Moore, Bethesda, MD.
K. S. Makeig.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 459-474, 3 Fig, 3 Tab, 31 Ref.

Descriptors: *Sludge disposal, *Leachates, *Nitrates, *Buffer zone, *Models, Trenches, *Path of pollutants, Sludge, Waste disposal, Model studies, Leaching, Land disposal, Permeability coefficient, Denitrification, Nitrogen, Aquifers, Advection, Waste dumps, Fate of pollutants.

A study was made to quantify the amount of buffer area needed around a narrow trench used for burial of sludge to allow the soil to stabilize leachate without threatening the surrounding groundwater supplies. A vertical buffer (thickness of unsaturated soil below the trench) can be calculated by comparing the cation exchange capacity of the soil with the exchangeable cations in the sludge leachate. Data from the Washington Suburban Sanitary Commission based on past sludge disposal practices in the metropolitan Washington, D.C. area indicate a vertical buffer < 3 ft thick is sufficient. The width of the horizontal buffer (a strip of land between the trench and the site boundary) is calculated from the nitrogen loading of the soil and the mobility of nitrate in the upper aquifer based on hydraulic conductivity and the sludge/soil interaction. The minimum width of a horizontal buffer for nitrates can be estimated by means of a simple, three-dimensional advection-dispersion model. The model can also be used to predict nitrate concentrations for various buffer widths. Natural stabilization in the soil can be supplemented by the planting of nitrate-using plants, the diversion of precipitation from the site, and lowering of the water table to increase the vertical buffer distance.
W85-05383

WATER QUALITY EFFECTS AND GROWTH BENEFITS OF ENTRENCHING SEWAGE SLUDGE IN SANDY FOREST SOILS,
North Central Forest Experiment Station, East Lansing, MI.
A. R. Harris, and D. H. Urie.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison. p 475-494, 8 Fig, 5 Tab, 13 Ref.

Descriptors: *Sludge disposal, *Leachate, *Path of pollutants, Absorption, Deciduous trees, *Sludge utilization, *Soil amendments, *Growth rates, Waste disposal, Recycling, Land disposal, Waste recovery, Solid wastes, Water quality, Leachates, Nitrates, Denitrification, Nitrogen, Trees, Sludge solids, Forest soils, Fate of pollutants, Nutrients.

Sewage sludge with 10% dry solids was entrenched at loading rates of 75 and 150 t/ha to measure its effects on water quality. Also, sludge cylinders 60 cm in diameter and 100 cm in depth with 10-, 15-, 20-, and 40-% dry solids were buried in a hybrid poplar nursery to measure rooting and other growth effects. Lateral leaching was minimal, and leaching from the bottom of the trench had minimal effect on groundwater quality because of dilution. In the nursery, concentrations of soluble constituents were directly related to dry solids content. Sludge constituents stayed bound tightly except for the soluble portion. pH increased in the soil. Growth response of hybrid poplars was directly related to availability of sludge nutrients. The high sludge loading rate results in nitrate pollution of any underlying water table aquifers but surrounding natural ecosystems should be able to denitrify and/or to assimilate the additional nitrogen. (Author's abstract)
W85-05384

ASSESSMENT OF POTENTIAL AGRICULTURAL AND INDUSTRIAL USES OF A LIME WATER-SOFTENING WASTE SLURRY,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 5G.
W85-05385

FACTORS AFFECTING THE VOLATILIZATION OF AMMONIA FROM LAND APPLIED SEWAGE SLUDGES,
Ohio State Univ., Columbus. Dept. of Agronomy.
T. J. Logan, W. C. Donovan, and R. H. Miller.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison. p 522-531, 1 Fig, 2 Tab, 12 Ref.

Descriptors: *Sludge, *Ammonia, *Volatility, *Nitrogen, *Soil properties, *Sludge disposal, *Sludge utilization, *Land disposal, Nutrients, Fertilizers, Vegetation, Soil water, Lime, Air temperature, Soil physical properties, Soil chemistry, Soil amendments, Limiting nutrients, Particle size.

A forced-air (60 liters/min) PVC cylinder manifold chamber was used to collect NH3 volatilized from sewage sludges applied to soil in bins in the laboratory. A series of experiments were conducted in which the effect on NH3 volatilization of a single variable was studied while holding all other conditions in a 'standard state.' The standard conditions included: Columbus Jackson Pike anaerobically digested sewage sludge applied at 5 mt/ha (dry weight) to a Crosby silt loam soil (pH 6.7) at 0.1 atm. initial moisture content. The soil was bare and the sludge was unincorporated during the 24 hr. study period. Air temperature was 26 +/- 2 degrees. The variable conditions were: soil moisture (air-dry, 0, 0.1 and 15 atm.), soil pH (5.1, 6.7, 7.5), sludge type (anaerobically digested Columbus liquid sludge, partially dewatered Columbus sludge, aerobic Medina sludge, lime stabilized primary Ashland sludge, composted Columbus sludge), time of incorporation (0, 1, 3, 6, 12, 24 hr) or unincorporated after sludge application, surface cover (bare, sod, straw), air temperature (12.8, 18.3, 26.7 degrees). Volatilization was significantly increased with increasing temperature and with increasing time before incorporation. There was a nonsignificant trend for greater volatilization at higher soil pH's. NH3 volatilization was higher from the sod and straw soil treatments than from bare soil when sludge contained large particles but not when the sludge was homogenized. Volatilization was greatest at 0 atm. (saturation) and lowest with air-dry soil. The greatest absolute and the highest percentage NH3 losses were from the lime stabilized Ashland sludge which had a pH of approximately 12. (Author's abstract)
W85-05386

EFFECTS OF MUNICIPAL SEWAGE SLUDGE-CAKE ON NITROGEN AND PHOSPHORUS DISTRIBUTIONS IN A PINE PLANTATION,
Department of Energy, Washington, DC. Office of Health and Environmental Research.
D. D. Richter, D. W. Johnson, and D. M. Ingram.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison. p 532-546, 1 Fig, 5 Tab, 24 Ref.

Descriptors: *Sludge disposal, *Sludge utilization, *Nitrogen, *Phosphorus, *Pine trees, *Soil-water-

plant relationships, *Leaching, *Forest soils, Land disposal, Trees, Phosphates, Nitrates, Ammonia, Nitrogen compounds, Soil water, Leachates.

Anaerobically digested and dewatered sewage sludge-cake was applied at a rate of 275 mg/ha to a recently clearcut Sequoia silt loam (Typic Hapludult) that was subsequently planted to loblolly pine. The sludge represented an application of about 1500 kg N/ha and 675 kg P/ha. After four growing seasons N and P distributions were determined in the plant-soil system. Soil solutions were sampled from B horizons in the first and fourth years after treatment to evaluate leaching losses of NO3(-), NH4(+), and PO4(3-). Four years after the sludge treatment, differences between sludge-treated and control plots in soil N and P amounted to about 1180 and 868 kg/ha, respectively, in the surface 15 cm of mineral soil. Residual effects persisted for soil-extractable PO4(3-), NO3(-), and NH4(+) with 30-, 10-, and 1.5-fold increases, respectively, in the surface 15 cm of mineral soil. Concentrations of NO3(-)-N in subsoil solutions increased shortly after the sludge treatment, although mean concentrations for individual water collections were not elevated above the USEPA drinking water standard of 10 ppm. Four years after treatment, mean NO3(-)-N concentrations in subsoil solutions were less than 2 ppm. Mean concentrations of NH4(+)-N and PO4(3-)-P in subsoil solutions did not exceed 1.0 and 0.03 ppm. (Author's abstract)
W85-05387

CASE HISTORY OF A CITY'S SUCCESSFUL LAND APPLICATION PROGRAM OF LIQUID SLUDGE ON SOD,
Burgess and Niple Ltd., Columbus, OH.
H. R. Stonerook, and R. E. Birkbeck.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison. p 557-569, 4 Fig, 7 Tab, 3 Ref.

Descriptors: *Sludge disposal, *Sludge utilization, *Wastewater disposal, Heavy metals, *Land disposal, *Liquid wastes, *Wastewater irrigation, *Sod, Cost analysis, Waste disposal, Monitoring, Groundwater pollution, Wastewater renovation, Grasses, Turf grasses, Ohio.

The city of Orville, Ohio has successfully disposed of sludge from its wastewater treatment plant for eight years by applying it to a commercial sod farm. Sod can accomodate a sludge vehicle at all stages of growth. There is no erosion from the applications and minimum surface runoff. Heavy metals are removed from the application site with the sod and there is no danger of consumption by animals or humans. To minimize abuse to the growing sod, sludge is delivered using high flotation type vehicles. The city, with pipe donated by the sod company, constructed a permanent sludge pump station utilizing a Moyno type pump to convey sludge from the concentrating channel at the treatment plant to the receiving lagoons adjacent to the sod farm. Site monitoring includes sampling of drainage ditches, streams, a storm sewer and an irrigation well. Maximum downstream values of Cd, Cu, Pb and Zn are slightly higher than upstream values. Monitoring of the west sod farm shows that downstream average values of Cr, Cu, Ni and Zn are significantly higher than upstream values. Samples of an industrial storm sewer show high average values of Cr, Cu and Zn. The irrigation well shows no significant change in water quality from upstream conditions. The total annual cost of sludge disposal in Orrville is estimated to be $68.85/dry ton of solids.
W85-05388

APPLYING LIQUID SLUDGE TO FOREST LAND: A DEMONSTRATION,
North Central Forest Experiment Station, East Lansing, MI.
J. H. Cooley.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison. p 547-556, 2 Fig, 6 Ref.

Descriptors: *Sludge, *Liquid wastes, *Wastewater disposal, *Land disposal, *Spray irrigation, *Wastewater irrigation, *Sludge utilization, *Forests, Waste disposal, Municipal wastes, Cost analysis, Michigan, Linings, Wastewater renovation, Michigan.

Liquid sludge was spread on a site in northern lower Michigan where jack pine had been clearcut and the slash burned. The municipal sludge was hauled from the wastewater treatment plant to the application site in 2,000-gallon tank trucks that were designed for cleaning septic tanks. Liquid sludge was either spread directly from the trucks or unloaded into temporary storage ponds. In both procedures, sludge was pumped up to 720 feet through aluminum irrigation pipe to a portable booster pump and then up to 160 feet through branch lines to spray irrigation guns. Spreading sludge directly from trucks, a crew of two drivers and one on-site worker applied about 5.700 gallons/man-day. Spreading from ponds, a crew of two truck drivers and two on-site workers applied about 7,000 gallons per man-day. Since the project did not continue long enough to establish useful life of the components, equipment costs could not be specifically determined. Michigan now requires PVC liners to prevent excessive leakage from temporary waste storage ponds. In view of this, portable aboveground storage tanks or spreading directly from trucks might be more cost effective.
W85-05389

LAND APPLICATION OF MUNICIPAL WASTEWATER TREATMENT PLANT SLUDGE, INDIANAPOLIS, INDIANA,
Reid, Quebe, Allison, Wilcox and Associates, Inc., Indiannapolis, IN.
E. E. Horsley, R. Riemer, and C. M. Robson.
In: Proceedings of the Fifth Annual Madison Conference of Applied Reearch and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison. p 570-577, 2 Tab.

Descriptors: *Land disposal, *Sludge utilization, *Sludge disposal, *Wastewater irrigation, *Wastewater disposal, *Spray irrigation, *Waste disposal, Crops, Municipal wastes, Hydrogen ion concentration, Corn, Soybeans, Heavy metals, Cadmium, Regulations, Polychlorinated biphenyls, Indiana.

During expansion of the Belmont Wastewater Treatment Plant in Indianapolis, it was decided to land-spread sludge from sludge lagoons and to fill lagoons with compacted fill for future plant construction. The subcontractor chose a rural area for sludge spreading and conducted an extensive public relations program to gain acceptance for the sludge spreading project. The contractor developed his own guidelines for sludge application which were approved by regulatory agencies. Only 1.12 kg of Cd/ha were to be applied. All soils were to be tested for Cd and heavy metals before sludge application and the results were to be filed at the County Courthouse. Soil pH had to be at least 6.5 before sludge application. No sludge could be applied after crops were planted. In the first year, only corn and/or soybeans could be planted. Prior to harvest, crops were to be tested for PCB levels. No grazing of animals was permitted for one crop-year after sludge application. The EPA and state agencies also required that application rates be determined for each site based on both sludge and soil characteristics, a hold harmless agreement between the landowner and state be established, and liability insurance in excess of $1 million be purchased to protect the state of Indiana. Due to severe weather conditions and equipment problems, the sludge spreading program took 3 years to complete. Analysis of crops for PCB and Cd showed that residues of these substances were well below limits for food crops.
W85-05390

LANDSPREADING OF SLUDGE IN NEW YORK STATE,
Clark (Philip J.), Corning, NY.
D. A. Faga.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison. p 578-595, 1 Ref.

Descriptors: *Land disposal, *Sludge disposal, *Public health, *Wastewater disposal, *Recycling, *Wastewater renovation, *Waste management, *Waste recovery, Heavy metals, Cadmium, New York, Hazardous materials, Regulations, Environmental policy, Environmental effects, Vegetable crops, Public policy, Solid Waste disposal.

At present, New York State has declared a two year moratorium on the land-spreading of sludge on prime agricultural land. The EPA, Food and Drug Administration and federal Department of Agriculture maintain that the use of high quality sludges on agricultural land, coupled with proper management procedures, should safeguard the consumer from contaminated crops and minimize any potential adverse effect on the environment. The Director of Toxic Chemicals Laboratory and Professor of Vegetable Crops at Cornell University had discouraged land spreading of sludge on agricultural land, holding that it is hazardous and the sludge is best incinerated. Others also feel that the 2-year moratorium should become a permanent ban. In the interim of the moratorium, the federal government will test the effects of sludge landspreading on vegetable crops. The Coordinator for the program on land recycling of municipal wastewater and sludge at Penn State found that sludge application to spoiled mine areas results in the growth of healthy vegetable cover of grasses and legumes. Part 360 and Part 364 of the State Environmental Conservation Law address the regulation of solid waste management facilities and the registration of septic tank cleaners and industrial waste collectors, respectively. The main effect of a ban on sludge spreading would be increased disposal costs.
W85-05391

VEGETABLE PROCESSING WASTEFLOWS: LIABILITY OR ASSET,
Wisconsin Univ.-Madison. Dept. of Soil Science.
G. A. Blondin, S. J. Comiskey, and J. M. Harkin.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison. p 596-610, 1 Fig, 4 Tab, 21 Ref.

Descriptors: *Waste recovery, *Recycling, *Sugars, *Alcohols, *Fruit crops, *Vegetable crops, Food processing wastes, *Reverse osmosis, Wastewater renovation, Wastewater disposal, Cost analysis, Waste management, Peas, Carrots, Beans, Beets, Potatoes, Corn, Industrial wastes, Membrane processes.

Wastewater from six major U.S. vegetable packs (pea, snap bean, sweet corn, beet, potato, and carrot) was examined in Wisconsin canneries to determine the daily fermentable sugar concentrations in selected wastewaters, total fermentable sugar recovery from reverse osmosis membrane processable wastewaters, and performance of certain of these wastewaters during initial stages of sugar concentrate production by membrane processes. Corn and potato wasteflows were found to be the best sources of recoverable fermentable sugars; the snap bean wasteflows were the poorest and wasteflows from pea, carrot and beet were intermediate. By selectively harvesting only three to five wasteflows from each process vegetable pack, the average concentration of recoverable soluble hexose in the suitable wastewaters is increased by a factor of 14 to 18 over that of the average total plant effluents. The value of feedstock of about 1.6 million tons of fermentable sugar, the major reduction in wasteflow BOD and disposal costs, and the reuse value of reverse osmosis permeate water would exceed process costs by a wide margin and increase incentive for industrial participation in such a project. The net energy yield of the alcohol which could be produced is about 50% of the total energy used by the fruit and vegetable processing industry.
W85-05392

CASE STUDY OF DESIGN PROCEDURES FOR A LAND TREATMENT OF WASTEWATER SYSTEM, DALTON, GEORGIA,
Golder Associates, Atlanta, GA.
For primary bibliographic entry see Field 5D.
W85-05393

ASSESSMENT OF THE RESIDUAL EFFECTS OF LONG-TERM SPRAY DISPOSAL OF AN INDUSTRIAL SLUDGE,
Tennessee Univ., Knoxville.
J. D. Wolt.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison. p 622-633, 3 Fig, 3 Tab, 6 Ref.

Descriptors: *Sludge disposal, *Solid waste disposal, *Spray irrigation, *Wastewater irrigation, *Heavy metals, *Absorption, *Fate of pollutants, *Land disposal, Waste disposal, Crop yield, Calcium, Wastewater renovation, Sludge utilization, Digested sludge, Industrial wastes.

Aerobic digest sludge (1.5% solids) derived from by-products of synthetic fiber manufacture was spray disposed for seven years at estimated dry solids loadings of 500 kg per ha per day. Ineffective spray head operation resulted in the heaviest sludge loadings at the centers of individual spray disposal plots. These loadings diminished radially outward from plot centers and approached zero at plot perimeters. Excessive hydraulic loadings led to eventual failure of the spray field. A portion of the spray disposal field comprising five spray heads was soil sampled and then reclaimed by chisel plowing, installing agricultural tile underdrain, and applying gypsum. Following reclamation efforts, the experimental area was again soil sampled and established to rye which was evaluated for yield and elemental uptake. Crop yield was inversely related to levels of past sludge addition and appeared to reflect soil heavy metal contents on the spray field. Soil Ca, from gypsum application, appeared to partially ameliorate potential toxic metal effects, probably from inhibition of heavy metal uptake by plants. Following the residual cropping assessment, spray disposal plots were established to Midland bermudagrass overseeded with rye. Various sludge spray disposal schemes were investigated to determine what levels of waste loading could be tolerated for continued utilization of the reclaimed spray disposal field. (Author's abstract)
W85-05394

LAND APPLICATION OF KRAFT PAPER MILL SLUDGES,
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
G. G. Simpson, L. D. King, and B. L. Carlile.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison. p 634-646, 1 Fig, 6 Tab, 4 Ref.

Descriptors: *Fly ash, *Sludge disposal, *Sludge utilization, *Soil amendments, *Pulp wastes, *Land disposal, *Soil properties, *Heavy metals, Nitrogen, Nitrogen compounds, Phosphorus, Calcium, Magnesium, Minerals, Hydrogen ion concentration, Industrial wastes, Corn, Forages, Soil chemistry, Crop yield, Absorption.

Kraft paper mill sludges and coal fly ash were evaluated as soil amendments for agriculture land application in laboratory and field tests and on-farm demonstrations. In the laboratory mineralization study, at 16 wk of incubation, inorganic N(NH4 + NO3) levels as a percent of applied N in the primary and secondary sludge treatments averaged 14% and 35%, respectively. Recovered sludge N averaged 70% for both sludges. Net immobilization of N was observed for the primary sludge treatments through 4 weeks. By 2 weeks, no net N immobilization was measured for secondary sludge treatments. Both primary and secondary sludge applications increased soil pH and extractable levels of P, K, Ca, Mg, and Na. In the field, mixtures of primary and secondary sludge-fly ash applied at rates of 108 and 54 mT/ha, respectively significantly increased fescue and corn yields compared to control plots. Yields from sludge amended plots were similar to yields obtained with commercial fertilizer. Sludge amendments did not effect metal uptake by crops. The effects of sludge additions on Hayesville loam topsoil and Codorus loam topsoil after crop harvest were increased pH and extractable levels of P, Ca, and Mg. One acre on-farm demonstrations of the effect of sludges on fescue and corn silage plots gave encouraging results. Cooperating farmers are now enthusiastic about continued land application of the sludges.
W85-05395

WASTE DISPOSAL MODELLING,
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
D. O. Pronger.
Water and Pollution Control, Vol. 123, No. 1, p 22-23, January-February, 1985. 2 Fig.

Descriptors: *Waste disposal, *Radioactive wastes, Canada, Model studies, Public health, Safety, Hazardous wastes.

Scientists who must develop toxic waste disposal techniques that accomodate nature's ever changing conditions are faced with difficult problems. Research currently underway at the Whiteshell Nuclear Research Establishment in Pinawa, Manitoba for radioactive waste disposal is expected to have some application to other areas of waste control. To contain and isolate nuclear fuel wastes, Atomic Energy of Canada Limited is developing a system of multiple barriers. Man-made barriers would include a stable, immobilized waste form, a corrosion-resistant metal container, and special impermeable material surrounding the container. Burial deep underground within a stable rock body in the Canadian Shield would further isolate the wastes, the rock acting as a natural barrier to the release of radioactive elements into the surrounding environment. This disposal concept is now being assessed for its safety and technical feasibility. (Baker-IVI)
W85-05463

RIVER QUALITY AND SEWAGE EFFLUENT STANDARDS,
Thames Water Authority (England). Northern Div.
For primary bibliographic entry see Field 5G.
W85-05515

5F. Water Treatment and Quality Alteration

STUDIES OF THE HALOGENATION OF DISSOLVED ORGANIC MATERIAL DURING THE CHLORINATION OF SALINE COOLING WATERS, THE MODEL COMPOUNDS RESORCINOL DIACETATE AND RESORCINOL DIMETHYL ETHER,
Southampton Univ. (England). Dept. of Chemistry.
A. G. Howard, R. A. Pizzie, and J. W. Whitehouse.
Water Research, Vol. 19, No. 2, p 241-248, 1985. 8 Fig, 2 Tab, 21 Ref.

Descriptors: *Water treatment, *Cooling water, *Halogenation, *Dissolved solids, *Organic matter, *Chlorination, *Saline water, *Resorcinol diacetate, *Resorcinol dimethyl ether, Seawater, Bromine, Haloforms, Hydrogen ion concentration.

In view of the complex nature of dissolved organic material (DOM) found in natural waters, it was necessary to employ model compounds to elucidate the consequences of water chlorination. Resorcinol has been widely adopted as a simple monomeric model of DOM. Incorporation of resorcinol into polymeric material with ester and ether linkages was simulated using resorcinol diacetate and resorcinol dimethyl ether; the effect of chlorination on these compounds was studied in seawater. Resorcinol diacetate (3.5 ppm) was chlorinated (2 ppm) in seawater buffered to acidities chosen to lie within approximately one pH unit of a typical seawater pH of 8.2; under these conditions the products were mainly brominated. At a lower pH, tribrominated resorcinol diacetate, was the major product with no observable formation of haloforms. At higher pH values a mixture of mono-, di-, and tribrominated resorcinol diacetates was formed together with measurable quantities of haloforms. At low chlorine concentrations, ring substitution products dominated while at higher chlorine levels ring cleavage occured and trihalomethanes were produced. Electrophilic chlorination of the model compounds in seawater appears to be slower than the formation of HOBr by oxidation of naturally occurring bromide. To minimize haloform production from compounds such as those studied, current evidence suggests that the chlorine sources should be acidic and dilution should be achieved as rapidly as possible in order to minimize the formation of localized pockets of highly concentrated chlorine. Minimizing haloform production will only result in the production of a more varied and less readily characterizable halogenated DOM. (Collier-IVI)
W85-04979

VIRION CONFORMATIONAL FORMS AND THE COMPLEX INACTIVATION KINETICS OF ECHOVIRUS BY CHLORINE IN WATER,
North Carolina Univ. at Chapel Hill. School of Medicine.
D. C. Young, and D. G. Sharp.
Applied and Environmental Microbiology, Vol. 49, No. 2, p 359-364, February, 1985. 8 Fig, 19 Ref. EPA grant R804635020.

Descriptors: *Viruses, *Echovirus, *Chlorine, *Disinfection, Water treatment, Hydrogen ion concentration.

Aberrant inactivation kinetics were observed when monodispersed echovirus type 1 (Farouk) was inactivated with chlorine. An initial 1 to 2 log unit decrease in titer was followed by a lag period, during which the titer stayed the same or increased, and this was followed by a final decline in titer. First-order kinetics were obtained with poliovirus type 1 under the same conditions. Isoelectric focusing studies of echovirus before chlorine treatment showed that the virus distributed into two pH-dependent and interconvertible isoelectric forms. After chlorine treatment all remaining virus infectivity was associated with a third pH-independent isoelectric form. The complex inactivation kinetics appeared to be due to shifts between these conformational forms during inactivation in certain ionic environments. Under certain conditions the conformational shifts resulted in substantial resistance of monodispersed echovirus to chlorine. (Author's abstract)
W85-05048

WATER REUSE: WHERE ARE WE HEADED,
Orange County Water District, Fountain Valley, CA.
For primary bibliographic entry see Field 5D.
W85-05116

ION-EXCHANGE PROCEDURES (IONENAUSTAUSCHVERFAHREN).
Wasser, Luft und Betrieb, Vol. 27, No. 12, p 18-20, December, 1983. 4 Fig, 3 Ref.

Descriptors: *Ion exchange, *Water treatment, *Wastewater treatment, Cation exchange, Anion exchange, Counterflow, Costs, Regeneration.

Ion exchange is only suited for the treatment of very lightly polluted water due to the limited capacity of its resins and the high cost of regenerating chemicals. The water must be free of mechanical pollution and oils and fats. Procedures offered include complete or partial water softening; decarbonization; removal of some or most salts; wastewater treatment (removal of cations by selective exchangers); reclamation of precious metals like platinum, gold, or silver out of the products of regenerating the exchanger; and application in rinse-water circulation in the metal-processing industry to reduce wastewater production. For salts removal, water is first routed through a cation-exchanger and then through an anion-ex-

changer; in order to continue to supply the production process with salts-free water during regeneration, a tank to store treated water, two tracks of exchangers, or serial switching of exchangers may be used. The two principal operational types of exchanger are the unidirectional-flow, fixed-bed procedure and the counterflow, floating-bed procedure. The advantage of the counterflow procedure is a savings in regenerating chemicals (120-150% of theoretical requirements are needed for counterflow, 250-400% for unidirectional flow). Variations of the counterflow, floating-bed procedure are the lift-bed and rinse-bed exchangers. A combined-bed filter (combination of cation and anion resins) can be used as a secondary procedure where low conductivity (< 5 microS/cm) is required. Cartridge exchangers are available for laboratory, pharmaceutical, and medical applications, where due to low volume on-site regeneration is impractical. (Gish-IVI)
W85-05137

RECYCLING UNDILUTED DRAGOUT FROM TOXIC PLATING SOLUTIONS,
Ramirez Associates, Far Hills, NJ.
E. R. Ramirez, and F. D. Koch.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 173-180. 8 Fig, 4 Tab, 4 Ref.

Descriptors: *Electroplating, *Wastewater, Waterless rinses, Dragout, Toxic plating solutions.

The use of waterless rinse liquids has opened a new dimension in the electroplating industry where toxic chemicals are commonplace. This includes chromium plating, brass plating followed by solvent based coatings, precious metal plating and electronic parts plating. Waterless rinses have several advantages. Custom formulations can be used to meet a wide variety of needs and applications. No wastewater or very little wastewater is formed in a given plating step. Recovered dragout, in many cases, can be reused; it always is confined. Waterless rinse liquids can be reused indefinitely without ill effects. No water stains are observed on the metal surface. This is especially valuable to jewelry type finishes. Waterless rinses can incorporate antitarnish and/or corrosion inhibitor additives which will allow steel parts, for example, a 60-day storage period without visible corrosion. Waterless rinses require less space than conventional rinses. Rinse coats are between 0.5 and 1 cent/sq ft of surface processed. Processed parts can be air dried through proper formulation. The limitations of waterless rinse technology are: waterless rinses cannot be used between plating steps and waterless rinses are combustible hydrocarbons.
W85-05242

WASTE HAULER/DISPOSER MEETS PRETREATMENT GUIDELINES,
QED Corp., Ann Arbor, MI.
F. E. Bernardin, Jr., D. Mioduszewski, and W. Hartman.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 369-373. 4 Tab.

Descriptors: *Activated carbon, *Leaching, *Runoff, *Wastewater treatment, *Wastewater disposal, Waste disposal, Lime, Activated carbon, Effluent, Industrial wastes.

Chem-Met Services Inc. is engaged in transport and treatment of liquid industrial wastes. During treatment the liquids are converted into a stabilized solid suitable for disposal at an offsite solid waste landfill. The treatment system has no direct process liquid effluent, however, precipitation runoff constitutes concern. The sampling and site survey conducted by QED field personnel provided both representative wastewater samples and also background in the Chem-Met treatment process capabilities and restrictions. The source of input to the runoff pond is rain or snowmelt. The rainwater can soak through any of the waste-lime mixture, which is sometimes retained on the site for a short period before removal to the landfill, leaching out the watersoluble components, which also end up in the pond. Due to the high and variable organic content, high TDS and potential for toxicity, physical chemical treatment was selected. The data indicate that a physical chemical system using granular activated carbon adsorption could be an economic treatment alternative. A small scale pilot test combined with high values for standard BOD tests indicate that treatment with GAC to remove toxic or biologically resistant materials followed by discharge to the municipal POTW for biological treatment is the most economical and viable approach for treatment of the runoff pond water. The major elements of the system are pH control, filtration and adsorption. The treatment system is electrically operated and manually controlled. An onsite laboratory monitors effluent quality.
W85-05260

IMPACT OF PRIORITY POLLUTANTS ON PUBLICLY OWNED TREATED WORKS PROCESSES: A LITERATURE REVIEW,
Montgomery (James M.), Inc., Walnut Creek, CA.
L. L. Russel, C. B. Cain, and D. I. Jenkins.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 871-883. 4 Tab, 26 Ref.

Descriptors: *Sewage systems, *Ordinances, *Industrial wastewater, Organic wastes, Standards, Inorganic compounds, Literature review.

Compounds most frequently found and regulated in sewer use ordinance are tabulated. There is a substantial range in the reported threshold values of the impacts, and there is a similar wide range in the reported levels found in waste treatment processes. An individual discharger may be hundreds of times higher than the discharger shown in this paper; however, his impact is diluted by the large quantities of water discharge into sewage systems. The reported threshold levels in the organics area are generally substantially greater than the levels found in waste treatment facilities. This is partly due to the impact of air stripping on the volatile compounds and their consequent removal during transport in the sewage system. The control of routine discharges of organics is generally not an area that needs substantial effort in the setting of industrial waste sewer use ordinances. Special conditions, such as the presence of a large manufacturing concern tributary to a moderate or small sized waste treatment facility would justify limits on organics. Standards for many toxicants, particularly inorganics, is justified. For the practicing engineer, the most difficult area becomes the assessment of what levels are significant with respect to impact on the treatment facility. It is necessary to both maximize the use of our waste treatment investment and to protect it.
W85-05300

INVESTIGATIONS ON THE INFLUENCE OF ALGOGENIC ORGANIC MATTER ON FLOCCULATION AND FLOCSEPARATION (UNTERSUCHUNGEN ZUR BEEINFLUSSUNG DER FLOCKUNG UND FLOCKENABTRENNUNG DURCH ALGENBURTIGE ORGANISCHE SUBSTANZEN),
Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).
H. Bernhardt, O. Hoyer, and B. Lusse.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 18, No. 1, p 16-17, February, 1985. 13 Fig, 6 Tab, 14 Ref.

Descriptors: *Water treatment, *Organic matter, *Flocculation, *Algae, Surface waters, Turbidity, Eutrophication, Diatoms, Filtration, Flocculants, Iron.

The flocculation and filtration of water from eutrophic surface waters is often disturbed by algogenic organic compounds which arise in the water as metabolic or breakdown products of algae. As a result of this disturbance, the turbidity is insufficiently retained in the filter, flocs break prematurely through the filter and increased concentrations of flocculant occur in the filtrate. With extracellular organic matter (EOM) obtained from optimized algal mass cultures, flocculation tests were carried out. These tests showed that, depending on the amount of flocculant used, at low concentrations the EOM behaved like an anionic flocculation aid, whereas at higher concentrations (> 1 mg/l C with a dosage of 5 mg/l Fe(3+)) it caused the flocculation disturbances described. Also, the high molecular weight fraction of the EOM exerted a greater influence on the flocculation process than the low molecular weight fraction (cut-off 2,000 Daltons). EOM from Chlorella cultures exerted no flocculation aid effect. The flocculation was influenced to different extents according to the algal species and growth phase. EOM obtained from the late stationary phase or the dying phase of an algal culture generally exerted a greater influence on flocculation than EOM from the logarithmic growth phase. Experiments with organic matter isolated from the eutrophic Wahnbach pre-reservoir during a mass development of diatoms (50,000 cells/ml) gave the same results. Using a dosage of 5 mg/l Fe(3+), the flocculation is impaired by > or = 1 mg/l DOC. In the presence of 4-5 mg/l DOC of the low molecular weight fraction, iron is bound in complexes and occurs in a soluble form. The effect of the extracellular organic matter from the different algal cultures and growth phases on the retention properties of the flocs in the filter is quantified with the filtration coefficient lambda. It could be demonstrated with the changes of lambda max values, that the effect of the EOM on the flocculation process was dependent on the amount of flocculant used, and that the disturbance to flocculation could be compensated to a certain extent by increasing the flocculant dosage. A comparison of the effects of the EOM from different algal cultures and different growth phases is given. (Author's abstract)
W85-05451

REACTION MECHANISMS INVOLVED IN THE INFLUENCE OF ALGOGENIC ORGANIC MATTER ON FLOCCULATION,
Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).
H. Bernhardt, O. Hoyer, H. Schell, and B. Lusse.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 18, No. 1, p 18-30, February, 1985. 26 Fig, 2 Tab, 38 Ref.

Descriptors: *Flocculation, *Filtration, *Water treatment, *Organic matter, *Algogenic matter, Polysaccharides, Chemical reactions.

Algogenic organic substances, especially neutral or acidic polysaccharides, can influence flocculant and floc filtration according to the ratio of their occurrence to the flocculant used and to the surface concentration of the negatively charged particles in the water to be treated. Low concentrations of organic matter improve flocculation by attachment to the surface of quartz particles by means of hydrogen and covalent bonds, thus favoring the agglomeration of the quartz particles already destabilized by polynuclear hydroxo complexes. In the presence of higher concentrations of algogenic organic matter, surface complexes are formed between the dissolved polymer anions and the positively charged iron hydroxo complexes and iron oxide hydroxides being formed after addition of the ferric salt. In the presence of higher concentrations of algogenic matter, an extensive or even complete loading of the active centers of the quartz particles occurs depending on the ratio of dissolved organic carbon to surface concentration. Their negative charge density is thus increased and the destabilization process significantly obstructed. More flocculant, and additional amounts of a cationic polyelectrolyte are then needed. These mechanisms can be used as models in the development of remedial procedures for preventing disturbances to flocculation processes during treatment of drinking water. (Baker-IVI)
W85-05452

ORIGINAL PURITY - DEMANDS AND CRITERIA ACCORDING TO THE NEW MINERAL WATER AND TABLE WATER ORDINANCE (URSPRUNGLICHE REINHEIT - ANFORDERUNG UND KRITERIEN NACH DER NEUEN MINERAL- UND TAFELWASSER-VERORDNUNG),

Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Wasserchemie und Chemische Balneologie.
K. E. Quentin.
Zeitschrift fur Wasser und Abwasser Forschung, Vol. 18 No. 1, p 36-40, February, 1985. 1 Tab, 6 Ref.

Descriptors: *Mineral water, *Water quality, *Regulations, *Germany (Federal Republic), Water pollution, Water quality standards, Standards.

According to the new ordinance (Verordnung uber Naturliches Mineralwasser, Quellwasser und Tafelwasser (Mineral- un Tafelwasser-Verordnung), 1 August, 1984. BGBl. I, 1036-1045, 1984. Federal Republic of Germany) mineral waters from natural origin have to have 'original purity'. Since this expression is not defined, a general basis for the original purity and orientating values for special substances are given. First of all a differentiation between geogenic constituents and anthropogenic pollutants in mineral waters is necessary. These criteria are important for the official certification of mineral waters and for their routine control as well. (Author's abstract)
W85-05453

DENVER'S SEVEN DECADES OF EXPERIENCE WITH CHLORAMINATION,
Denver Water Dept., CO.
J. C. Dice.
Journal of American Waterworks Association, Vol. 77, No. 1, p 34-37, January, 1985. 1 Fig, 5 Tab, 1 Ref.

Descriptors: *Chloramines, *Drinking water, *Disinfection, Water treatment, Denver, Colorado, Taste control, Odor control, Bacteria, Water distribution, Water quality control.

The Denver Water Department has had nearly 70 years of success with the chlorine-ammonia process of disinfection of drinking water, having begun such treatment in 1916 or 1917. This method is used to control tastes and odors, bacterial concentrations, and growths in the distribution system. The success of this program can be attributed to a high quality raw water, a comprehensive monitoring program that provides data for studies, ongoing investigations, and a well operated distribution system maintenance program. Utilities that are investigating the use of chloramines should consider the quality of the source water and the extent of the monetary resources available for comprehensive monitoring and maintenance. (Baker-IVI)
W85-05473

CONVERTING FROM CHLORINE TO CHLORAMINES: A CASE STUDY,
Montgomery (James M.), Inc., Pasadena, CA.
P. Kreft, M. Umphres, J.-M. Hand, C. Tate, and M. J. McGuire.
Journal of the American Water Works Association, Vol. 77, No. 1, p 38-45, January, 1985. 5 Fig, 2 Tab, 30 Ref.

Descriptors: *Disinfection, *Chloramines, *California, Drinking water, Water treatment, Costs, Financial aspects, Taste control, Odor control, Reservoirs, Water quality control, Trihalomethanes.

The Metropolitan Water District of Southern California, one of the largest water utilities in the US, has changed from chlorine in its disinfection process to chloramines for controlling the formation of trihalomethanes (THM). Informative pamphlets were distributed to the customers to explain the reasons for the change and the adjustments that some users would find necessary because of the change. The effectiveness of chloramine disinfection was carefully investigated before the change from chlorine treatment was implemented. Various issues evaluated included chlorine and chloramine chemistry and by products, disinfection capability, taste and odor control, growth control in uncovered reservoirs, effectiveness of chloramine residual in distribution system piping, health effects of chloramines, implications for Metropolitan's member agencies, technological feasibility, and costs. Bench scale studies indicated that removal of THM precursors would not be sufficient to control THMs on a long term basis, thus indicating the necessity for the entire system to be converted to chloramine disinfection. The conversion to chloramines required modification of the operations at the five filtration plants and two finished water reservoirs. Modifications at Lake Mathews, a raw water reservoir that currently has a major chlorination facility, were also considered. The actual capital cost for modifications excluding Lake Mathews was 5.2 millon dollars. Annual costs, including ammonia, materials, electricity, and miscellaneous items are estimated to be $650,000. (Baker-IVI)
W85-05474

STATE REGULATION OF CHLORAMINATION,
Missouri Dept. of Natural Resources, Jefferson City. Public Drinking Water Program.
D. J. Hack.
Journal of the American Water Works Association, Vol. 77, No. 1, p 46-49, January, 1985. 5 Fig, 2 Tab.

Descriptors: *Disinfection, *Chloramine, *Regulations, Monitoring, Policy, Trihalomethanes, Water treatment, Bacteria, Drinking water.

The results of a survey conducted by the American Water Works Association Disinfection Committee into the practice of chloramination in the US states and territories are presented. One area of the study explored the policies and experiences of state water supply regulatory agencies with regard to the use of chloramines. Most of the information was gathered through a questionnaire sent in March 1984 to the director of each state's or territory's public water supply regulatory agency. Forty-six percent of the respondents reported that none of their public water suppliers used chloramination. In response to the question of changes in the use of chloramination as a result of trihalomethane regulations, 86% reported no change in policy. To a question designed to determine minimum combined chlorine residual and detention time requirements for the use of chloramines as the primary disinfectant, 29% responded that they will not allow chloramines as a primary disinfectant; 41% reported having not yet established minimum residual and detention time requirements. As concerns bacteriological monitoring, 38% of those responding reported that their requirements for additional monitoring follow EPA recommendations. Thirty percent reported that they do not require water suppliers proposing a change to conduct additional monitoring. (Baker-IVI)
W85-05475

BLENDING CHLORAMINATED AND CHLORINATED WATERS,
Southern California Metropolitan Water District, La Verne.
S. E. Barrett, M. K. Davis, and M. J. McGuire.
Journal of the American Water Works Association, Vol. 77, No. 1, p 50-61, January, 1985. 11 Fig, 6 Tab, 26 Ref.

Descriptors: *Chloramine, *Chlorination, *Disinfection, *California, Chlorine, Water quality control, Drinking water, Water treatment, Trihalomethanes, Ammonia.

The Metropolitan Water District of Southern California recently changed its primary disinfectant from free chlorine to chloramines to help control trihalomethanes. The effects of blending chloraminated and chlorinated waters were studied by developing blend-residual curves to simulate the systems involved. Experimentally determined blend-residual curves compare reasonably well with a simple computational model and with the trend predicted from conventional breakpoint curves. The computational model allows the prediction of acceptable blends of chloraminated and chlorinated waters for use in a distribution system without experimentally determining each case. When the contact time for blending the chloraminated and chlorinated waters is short (on the order of 5 min), free chlorine, monochloramine, and dichloroamine may exist together in the region of the breakpoint. If there is a change that a chlorine to ammonia-nitrogen ratio of >5:1 exists, additional analyses for the various chlorine species and for excess and total ammonia-nitrogen may be needed as a check on the operation of the distribution system. (Baker-IVI)
W85-05476

TECHNICAL NOTE: MONOCHLORAMINE REMOVAL FROM WATER BY ACTIVATED CARBON,
Brown and Caldwell, Seattle, WA.
J. D. Komorita, and V. L. Snoeyink.
Journal of the American Water Works Association, Vol. 77, No. 1, p 62-64, January, 1985. 3 Fig, 2 Tab, 13 Ref.

Descriptors: *Water treatment, *Monochloramine, *Potable water, *Activated carbon, Public health, Hemodialysis, Ammonium chloride, Organic matter, Disinfection.

Monochloramine is becoming a popular alternative to chlorine for the disinfection of water supplies as it does not react with humic substances to form trihalomethanes. Monochloramines must be removed from water used for hemodialysis and the production of soft drinks as well as from water used in fisheries. A study of tap water was carried out to determine the effects of particle size, contact time, and dissolved organic matter on carbon column effluent concentration when a typical influent monochloramine concentration was used. In general, the smaller the carbon particles and the longer the contact time (CT), the greater the life of the carbon for destruction of ammonium chloride. The estimated replacement frequency for a kidney dialysis unit utilizing a GAC removal system containing 1 cu ft of carbon operating 8 hr/d with a flow rate of 3.74 gpm and a CT of 2 min is 4 days for 10x30 mesh carbon, 83 days for 12x40 mesh carbon, and 213 days for 20x50 mesh carbon. If the flow rate were changed, the replacement frequency would have to be modified. These replacement frequencies are specific for the tap water tested. When the water was spiked with peat fulvic acid to a total organic carbon of 7.5 mg/L and fed to 20x50 mesh carbon, the volume processed to an ammonium chloride breakthrough concentration of 0.1 mg as Cl2/L was decreased by about 70 and 40 percent for CTs of 0.75 and 1.0 min, respectively. The dissolved organic compounds in other waters may have a different effect on bed life. The type of carbon used may have a significant effect on its performance for ammonium chloride removal. (Baker-IVI)
W85-05477

EXPERIENCE WITH CHLORINE DIOXIDE IN BRUSSELS, PART 3: OPERATIONAL CASE STUDIES,
International Inst. of Hydraulic and Environmental Engineering, Delft (Netherlands).
W. J. Masschelein.
Journal of the American Water Works Association, Vol. 77, No. 1, p 73-80, January, 1985. 11 Fig, 2 Tab, 11 Ref.

Descriptors: *Potable water, *Chlorine dioxide, *Belgium, *Brussels, Water treatment, Chloramines, Disinfection, Chlorination, Costs, Trihalomethanes.

Brussels, Belgium obtains much of its potable water supply from the River Meuse. The river is affected by human sewage, algal blooms, humic substances, and the infusion of hard groundwater. Chlorine dioxide is used at treatment plants, pumping stations, and clear water reservoirs along the aqueducts for bacterial disinfection and to prevent trihalomethane formation. The policy of postdisinfection with chloramines generated on-site and subsequent treatment with chloride dioxide has had excellent results in controlling trihalomethanes in the distributed water. A cost evaluation was performed in 1981. Besides the advantages of using chlorine dioxide for disinfectant and for eliminating residual taste and odor, one benefit for mainte-

nance of an active residual concentration of disinfectant in the distribution system is that it is compatible with existing chloramines without increasing the concentration of trihalomethanes. Another benefit of chlorine dioxide is that it promotes better coagulation-flocculation, especially when colored compounds are present in the raw water. Safe and efficient use of chlorine dioxide requires appropriate dilution and injection rates. Particular attention must be paid to the mixing conditions in the reactor, the appropriate reagent concentrations, and the residual akalinity in the reactor effluent or in stored, concentrated solutions. (Baker-IVI)
W85-05479

WINTER WATER AND WASTEWATER OPERATIONS,
For primary bibliographic entry see Field 5D.
W85-05481

INTERACTIVE COMPUTER MODELING, MONITORING, AND CONTROL OF MELBOURNE'S WATER SUPPLY SYSTEM,
Melbourne and Metropolitan Board of Works (Australia).
G. O. Cosgriff, P. E. Forte, M. A. Kennedy, J. V. Russell, and R. D. Smith.
Water Resources Research, Vol. 21, No. 2, p 123-129, February, 1985. 4 Fig, 8 Ref.

Descriptors: *Computers, *Water conveyance, *Model studies, *Monitoring, *Melbourne, *Australia, Water resources development, Planning, Decision making, Telemetry, Automation.

Application of computer-based telemetry and modeling techniques has revolutionized the planning and operations of Melbourne's water supply system and has provided a basis for many cost effective changes throughout the area. These engineering tools have already increased feedback and analysis capabilities, which in turn has resulted in a better understanding of the hydraulic system by use of common display terminals through the planning, plant design, operations and maintenance functions in the organization. Such changes have been achieved through a multidisciplinary approach which enabled the integration of a broad spectrum of skills within the area to produce an integrated system, the benefits of which extend beyond the immediate application and into the philosophy of the structure of the organization itself. (Baker-IVI)
W85-05492

BACTERICIDAL PROPERTIES OF A NEW WATER DISINFECTANT,
Auburn Univ., AL. Dept. of Chemistry.
D. E. Williams, S. D. Worley, W. B. Wheatley, and L. J. Swango.
Applied and Environmental Microbiology, Vol. 49, No. 3, p 637-643, March, 1985. 7 Fig, 4 Tab, 15 Ref.

Descriptors: *Water treatment, *Disinfection, *Agent I, Bacteria, Chloramines, Calcium hypochlorite, Temperature effects, Hydrogen ion concentration, Water quality, Organic compounds.

The N-chloramine compound 3-chloro-4,4-dimethyl-2-oxazolidinone (agent I) has been compared with calcium hypochlorite as to its efficacy as a bactericide for the treatment of water. Calcium hypochlorite proved to be a more rapid water disinfectant than agent I against three species of bacteria in demand-free water. The differences between the efficacy of the two agents in demand-free water are dependent on pH, temperature, and the species of bacteria. For water containing an appreciable organic load, agent I is the better disinfectant under all conditions when total chlorine concentrations in the range used for water disinfection in the field are employed. Any discussion of the specific mechanistic actions of the two disinfectants should be deferrred until additional experiments are performed. (Baker-IVI)
W85-05511

ASPECTS OF WATER AND SEWAGE TREATMENT IN AUSTRALIA,
Gutteridge, Haskins and Davey, Melbourne (Australia).
A. G. Strom.
Journal of the Institute of Water Engineers and Scientists, Vol. 38, No. 6, p 493-510, December, 1984. 6 Fig.

Descriptors: *Wastewater treatment, *Water treatment, *Australia, *Reviews, Urban areas, Costs, Lagoon treatment, Effluents, Water quality.

A review is presented of water treatment and sewage treatment practices in Australia today. These comprise a wide range of techniques, with overseas influences adapted well in the main to Australian conditions. The paper deals with processes and aspects of processes and gives examples. The main urban centers in Australia are now adequately served in terms of treatment of water and sewage, and new technology is adopted readily and in the main, sensibly. The situation in the country towns is both good and bad. The good is that with ample space and favorable climate, the economical lagoon treatment of sewage is possible. The bad is that water treatment costs are often unnecessarily high because pressure for, and reliance on, state funding results in higher water standards than are necessary in the circumstances. New forms of water treatment such as Sirofloc and Sirotherm have resulted from some basic research and innovation, but more generally overseas research is drawn upon. Applied research has developed mainly lagoon treatment, re-use of effluent, and refinement of the denitrifying Pasveer Ditch for small communities. The sparse population and lack of significant industry has resulted in minimal incidence of water-borne enteric disease or of chemical or other industrial pollution of water sources. This may partly explain why many country towns have tolerated supplies of very poor apparent quality for so long. (Baker-IVI)
W85-05514

EXPERIENCES IN THE USE OF EAST ANGLIAN SANDS AND GRAVELS ('CRAGS') AS A SOURCE OF WATER SUPPLY,
East Anglian Water Co., Cambridge (England).
K. B. Clarke, and J. H. Phillips.
Journal of the Institution of Water Engineers and Scientists, Vol. 38, No. 6, p 543-549, December, 1984. 2 Fig, 5 Ref.

Descriptors: *Water supply development, *Water treatment, *Crags, *East Anglia, *England, Water resources development, Aquifer properties, Groundwater management, Iron, Manganese, Filtration, Hydrogen sulfide, Wells.

The crag is an unpromising acquifer and had previously been of little use as a source of public water supply in Suffolk except for three small coastal towns. Typically it is a heavily iron stained sand with occasional lenses of gravel. When it became apparent that the East Anglian Water Company might be forced by the advent of the Sizewell B Nuclear Power Station to develop a major water source in the crag, advice was sought on many issues. Attempts made to use the crag for water supply were said to have two major disadvantages. Firstly, there was the sanding up of wells after a few years use, caused by the slow ingress of fine sand into the wells. The second problem was the heavy iron content of the water. The use of a reverse circulation rig proved ideal for well sinking in the crag, mains water was available on or near the sites developed and this allowed a supply, at times up to 22,700 l/hr during the passage of open textured zones in the crag. Crag waters are high in iron and manganese, and also contain hydrogen sulfide. Where iron and manganese occur together their removal seems especially difficult. A pilot plant was set up to give guidance. Iron upon oxidation tends to be precipitated in almost colloidal form, and in some works a coagulent aid has been used with success. Removal of manganese within the filter seems to be a process which depends on the reaction with manganese already present on the sand grains. If iron is also being removed the grains appear to become choked with it and removal of manganese is minimal. The process finally adopted at the plant was one of double filtration. After aeration the water passes through upward flow filters which reduce the iron level to less than 0.1 mg/l. The water is then chlorinated and allowed to stand for six hours. Finally water is pumped from the tank through pressure filters into supply. (Baker-IVI)
W85-05517

AUTOMATED IODOMETRIC METHOD FOR DETERMINATION OF TRACE CHLORATE ION USING FLOW INJECTION ANALYSIS,
Miami Univ., Oxford, OH. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W85-05519

WATERBORNE DISEASE IN COLORADO: THREE YEARS' SURVEILLANCE AND 18 OUTBREAKS,
Colorado Dept. of Health, Denver. Disease Control and Epidemiology Div.
R. S. Hopkins, P. Shillam, B. Gaspard, L. Eisnach, and R. J. Karlin.
American Journal of Public Health, Vol. 75, No. 3, p 254-257, March, 1985. 1 Tab, 6 Ref.

Descriptors: *Public health, *Human diseases, *Colorado, Bacteria, Giardia, Rotavirus, Epidemiology, Water treatment, Filtration, Coliforms.

A steady increase was noted in the number of reported waterborne disease outbreaks occurring in the US since the early 1960s. Efforts were made to more closely survey such outbreaks. In suspected occurrences, water samples were collected and examined for total coliforms and fecal coliforms. In outbreaks of suspected giardiasis, 1,000 gallons each of treated and untreated water were filtered through a one micron filter and the filter examined for the presence of Giardia cysts. From July 1, 1980 through June 30, 1983, 18 outbreaks were investigated which involved from 15 to 1,500 individuals. Giardia lamblia was confirmed or suspected in nine, rotavirus in one, and no agent could be identified in eight outbreaks. Seventeen occurred in surface water systems, none of which had adequate chemical pretreatment and filtration. Effective, inexpensive surface water treatment methods could substantially reduce the risk of waterborne disease. Investigation of water systems exhibiting positive coliform results during the first year detected no outbreaks. Activities important to effective surveillance included educational outreach programs to local health agencies, physicians and the public, and the designation of one individual to whom all water related public complaints and health department inquiries were directed. (Baker-IVI)
W85-05521

HYDRAULIC GRADIENT CONTROL FOR GROUNDWATER CONTAMINANT REMOVAL,
Geological Survey, Menlo Park, CA.
D. F. Atwood, and S. M. Gorelick.
Journal of Hydrology, Vol. 76, No. 1/2, p 85-106, January, 1985. 11 Fig, 1 Tab, 17 Ref.

Descriptors: *Groundwater pollution, *Water pollution control, *Groundwater management, Linear programming, Solute transport, Groundwater flow, Simulation, Hydraulic gradient, Cleanup operations, Decontamination, Plumes, Aquifers, Wells.

A procedure is presented which integrates the use of linear programming, groundwater flow simulation and solute transport simulation to solve problems involving groundwater contaminant control. This procedure selected the best wells and the pumping/recharge schedules to contain a contaminant plume, while a well or system of wells within the plume removes contaminated water. Wells used for hydraulic gradient control are picked from preselected well sites and must be outside of the zone of contaminated groundwaters. Pumping at upgradient wells or recharging at downgradient wells produces a flat or inwward gradient at the plume boundary. As the plume decreases in size,

potential gradient control wells initially within the zone of contamination (and therefore inactive) become surrounded by clean water. Once the wells are outside the contaminant plume they may be selected by the management model to help control the hydraulic gradient. Well sites distant from the plume boundary in later periods may be shut down in the management solution. The procedure used for selecting the best wells to use consists of two parts. In stage I, a combined groundwater flow and solute transport model is used to simulate contaminant removal under an assumed velocity field. The result is the approximated plume boundary location as a function of time. In stage II, a linear program, which includes a groundwater flow model as part of the set of constraints, determines the optimal well selection and their optimal, pumping/recharge schedules by minimizing total pumping and recharge. The simulation-management model eliminates wells far from the plume perimeter and activates wells near the perimeter as the plume decreases in size. This successfully stabilizes the hydraulic gradient during aquifer cleanup. (Baker-IV)
W85-05533

OZONE ENHANCED BIOLOGICAL ACTIVATED CARBON IN DENVER, COLORADO: A PILOT PLANT STUDY,
Arber (Richard P.) Associates, Inc., Denver, CO.
For primary bibliographic entry see Field 5D.
W85-05826

KINETICS AND PRODUCTS OF THE REACTIONS OF OZONE WITH VARIOUS FORMS OF CHLORINE AND BROMINE IN WATER,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
W. R. Haag, and J. Hoigne.
Ozone: Science and Engineering, Vol. 6, No. 2, p 103-114, 1984. 7 Fig, 1 Tab, 20 Ref.

Descriptors: *Ozonation, *Chemical reactions, *Chlorine, *Bromine, *Water treatment, Oxidation, Halogens, Disinfection.

Ozone may react with various halogen compounds during water treatment. The oxidation of Br(-) by O3 in natural waters produces HOBr as a secondary oxidant and disinfectant. HOBr can result in the formation of bromoform. HOBr will be oxidized further to BrO3(-) at high pH and high O3/Br(-) ratios. Under such conditions, the ozonolysis of organic matter will become inefficient because considerable amounts of O3 are destroyed catalytically by the Br(-)/OBr(-) couple. Ozonation of saline cooling waters for antifouling would appear to offer little advantage over less-expensive chlorination because, among several reasons, the same disinfecting oxidant (HOBr) is produced. Free chlorine reacts with O3 to produce 77% Cl(-) and 23% ClO3(-); however, Cl(-) is not reoxidized to HOCl so no catalytic O3 destruction occurs. (Collier-IVI)
W85-05828

5G. Water Quality Control

EVALUATION OF ALTERNATIVE POLICIES FOR CONTROLLING AGRICULTURAL NON-POINT SOURCE POLLUTION,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6B.
W85-04989

SIDE EFFECTS OF 58 YEARS OF COPPER SULFATE TREATMENT OF THE FAIRMONT LAKES, MINNESOTA,
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
M. J. Hanson, and H. G. Stefan.
Water Resources Bulletin, Vol. 20, No. 6, p 889-900, December, 1984. 7 Fig, 7 Tab, 26 Ref.

Descriptors: *Copper sulfate, *Fairmont Lakes, *Minnesota, *Algae, *Algicides, Ecological effects, Fish populations, Dissolved oxygen, Fish kills, Chlorophyta, Cyanophyta.

The shallow Fairmont Lakes in southern Minnesota have been treated with copper sulfate for 58 years to reduce excessive algal growth. Copper sulfate was applied to five lakes at cumulative rates up to 1647 kg/ha (1470 lb/acre), totaling 1.5 million kilograms. Data collected since treatment of the Fairmont Lakes began in 1921 provide alarming insights into lake responses to sustained chemical treatment with copper sulfate. Short-term and long-term effects have occurred. Short-term effects include: a) the intended temporary killing of algae, b) dissolved oxygen depletion by decomposition of dead algae, c) accelerated phosphorus recycling from the lake bed and recovery of the algal population within 7 to 21 days, and d) occasional fish kills due to oxygen depletion or copper toxicity or both. Long-term effects are shown to include: a) copper accumulation in the sediments, b) tolerance adjustments of certain species of algae to higher copper sulfate dosages, c) shift of species from green to blue-green algae and from game fish to rough fish, d) disappearance of macrophytes, and e) reductions in benthic macroinvertebrates. The conclusion is that while copper sulfate treatments enjoy great popularity because they kill and remove algae almost instantaneously, other immediate or cumulative side effects can be harmful to many other aquatic organisms. (Author's abstract)
W85-04996

REMOVAL OF VOLATILE CHLORINATED HYDROCARBONS FROM GROUNDWATER (ENTFERNUNG LEICHTFLUCHTIGER CHLORKOHLENWASSERSTOFFE AUS GRUNDWASSER),
M. Kertess.
Wasser, Luft und Betrieb, Vol. 27, No. 11, p 20-22, November, 1983. 1 Fig.

Descriptors: *Chlorinated hydrocarbons, *Groundwater pollution, *Water pollution control, *Wastewater treatment, Volatile compounds, Trichlorethylene, Tetrachlorethylene, Adsorption, Methylene chloride, Trichlorethane, Dichlorethylene.

Efforts of a chemical company in Hannover, Federal Republic of Germany to remove volatile chlorinated hydrocarbons (CHC) originating on its site and polluting nearby emergency drinking-water wells are described. Tri- and tetrachlorethylene were found to be polluting the wells in 1976, and responsibilty for clean-up was passed to the company when government agencies could not provide a technically feasible solution. A company specializing in wastewater technology designed a fully automatic compact treatment facility with a 97% removal rate. The facility is based on the application of pollution-removing products and chemically reacting adsorbents: for heavily polluted wastewater, these are used for both preliminary and tertiary treatment with activated-charcoal treatment as a second stage; while for lightly polluted wastewater and water, these are applied as a second and final stage preceded by activated-charcoal treatment. Treatment cost at the facility is DM 1.00/cu m. The question should be addressed as to whether CHC should be banned by law. Cooperation between government and the private sector is not encouraged by fines and responsibility for clean-up being placed on the polluter without suggestions for clean-up implementation. In this case, tri- and tetrachlorethylenes, 1,1,1-trichlorethane, and methylene chloride have largely been removed, but cis-1,2-dichlorethylene has now emerged as the main component so that the problem of CHC pollution has not yet been solved. (Gish-IVI)
W85-05136

CONTINUOUS DETECTION OF POLLUTANTS ON SURFACES OF RUNNING WATER (KONTINUIERLICHER NACHWEIS VON VERUNREINIGUNGEN AUF OBERFLACHEN VON FLIESSENDEN GEWASSERN),
Strohlein GmbH and Co. 4044 Kaarst 1.
For primary bibliographic entry see Field 5A.
W85-05140

RESERVOIR RELEASE IMPROVEMENT,
Tennessee Valley Authority, Chattanooga. Div. of Water Resources.
C. E. Bohac, E. D. Harshbarger, J. L. Davis, R. J. Ruane, and S. Vigander.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 847-859. 16 Fig, 2 Tab, 12 Ref.

Descriptors: *Reservoir releases, *Baffles, *Dissolved oxygen, Wastewater treatment, Cost analysis, Dams, Aeration, Fisheries, Recreation, Norris Dam.

Significant amounts of air can be induced into hydroturbine draft tubes by properly designed baffled aspiration systems. There is an energy and capacity loss associated with the baffles and additional losses associated with the presence of air in the draft tube. Based on tests at Norris Dam, dissolved oxygen uptake on the order of 3-4 mg/l is possible using baffles at the expense of a loss of 2-3% in unit efficiency. Blowers might prove to be more advantageous than baffles because blowers would confine the power loss to only the period of aeration. In general, the cost of providing minimum flows below TVA reservoirs by bypassing generators is likely to exceed the benefits derived from improved fisheries or recreation. The relative cost analysis suggests that cost increases rapidly for providing DO increases above 2-3 mg/l. The comparison of aeration to advanced waste treatment systems points to the possibility that release improvement would be more economically efficient than the imposition of additional treatment requirements for DO control in certain instances.
W85-05298

LIMING OF ACIDIFIED WATERS: A REVIEW OF METHODS AND EFFECTS ON AQUATIC ECOSYSTEMS,
General Research Corp., McLean, VA.
For primary bibliographic entry see Field 5C.
W85-05310

PROTECTING THE NATION'S GROUNDWATER FROM CONTAMINATION.
Office of Technology Assessment, Washington, DC.
Available from Supt. of Documents, GPO, Washington, D.C. 20402. OTA-0-233, October 1984, 244 p. 6 Fig, 40 Tab, 174 Ref.

Descriptors: *Groundwater pollution, *Groundwater management, *Water quality control, *Water quality management, *Water pollution prevention, *Water pollution control, *Reviews, *Environmental effects, Environmental policy, Federal government, Environmental protection, Local governments, Hazardous materials, Water pollution sources, Fate of pollutants, Path of pollutants, Drinking water.

Contamination of groundwater in the United States has occurred in every state and should warrant attention. The protection of groundwater quality involves activities to detect, correct and prevent contamination in order to minimize associated impacts. Federal and State programs generally focus on managing only selected point sources of contamination, particularly point sources associated with hazardous wastes. Under the National Interim Primary Drinking Water Regulations of the Safe Drinking Water Act, only 22 mandatory water quality standards have been established. Many states have set their own standards for drinking water and groundwater quality. The extent to which people relying on private wells are being exposed to groundwater contaminants is unknown. Data are also unavailable about the impacts of groundwater contamination on non-drinking water uses. Corrective action programs such as the Comprehensive Environmental Response, Compensation and Liability Act have concentrated on hazardous waste sites and generally do not involve the cleanup of contaminated groundwater. Likewise, most programs to prevent groundwater contamination have focussed primarily on hazardous wastes and other toxic materials. A focus on sources is one approach to prevent contamination. Another

approach is through restrictions on the manufacture or generation, distribution and use of contaminants, such as pesticides. Technological constraints to protect groundwater quality may include difficult geological environments that inhibit monitoring efforts. Non-technological constraints may include lack of time or money required to implement programs. National policy must remain flexible in its ability to respond to different groundwater quality problems characterized by varying site conditions.
W85-05348

FIELD INVESTIGATION AND REMEDIAL ACTION AT A SITE CONTAMINATED WITH COAL TARS,
TRC Environmental Consultants, Inc., East Hartford, CT.
For primary bibliographic entry see Field 5E.
W85-05377

GROUNDWATER QUALITY PROTECTION: POLICIES AND TECHNICAL RESOURCES,
Wisconsin Univ.-Extension, Madison. Dept. of Engineering and Applied Science.
P. R. O'Leary.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, 1982. Wisconsin Univ. -Extension, Dept. of Engineering and Applied Science, Madison. p 421-432, 9 Ref.

Descriptors: *Groundwater management, *Public policy, *Design criteria, *Water quality standards, *Water quality control, *Water quality management, *Models, *Public participation, Regulations, Standards, Waste disposal, Groundwater pollution, Water pollution control, Fate of pollutants, Monitoring, Public relations.

Interest in developing groundwater quality protection programs is receiving national attention. Identifying the appropriate level of protection is a difficult technical and public policy issue. Standards may be groundwater quality based, setting maximum levels of contamination, or the standards may take the form of disposal site construction specifications. In order to ensure the disposal facility will not cause a groundwater problem, the designer must be prepared to model both the performance of waste systems and contaminant movement in the groundwater flow system. Careful follow up groundwater monitoring is also needed to verify the results. Parallel considerations are the availability of technical expertise to accomplish the necessary analysis and the financial commitment to develop high quality data. Recognizing that the public has a keen interest in protecting groundwater quality, techniques must be employed to enhance public understanding. (Author's abstract)
W85-05381

ASSESSMENT OF POTENTIAL AGRICULTURAL AND INDUSTRIAL USES OF A LIME WATER-SOFTENING WASTE SLURRY,
Illinois State Geological Survey Div., Champaign.
J. H. Goodwin, I. G. Krapac, P. C. Reed, and W. R. Roy.
In: Proceedings of the Fifth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste, WI, September 22-24, Madison. p 495-521, 7 Fig, 8 Tab, 29 Ref.

Descriptors: *Spray irrigation, *Trace elements, *Slurries, *Lime, Waste recovery, *Land disposal, *Wastewater renovation, *Water treatment, *Leachates, *Calcium, *Recycling, Hydrogen ion concentration, Conductivity, Alkalinity, Minerals, Soft water, Hazardous material, Computer models, Illinois.

The Illinois State Geological Survey in cooperation with the Northern Illinois Water Corporation had conducted a program of sampling and analysis of lime slurry from lime water-softening treatment of well water currently sold as an agricultural liming material to be sprayed on fields. Slurry solids were analyzed for six major, three minor, and 17 trace elements, dry and wet specific gravity and density, x-ray mineralogy, particle size, and moisture content. Water samples were analyzed for 21 elements and Eh, pH, EC and alkalinity values. Preliminary studies of the vertical and areal variability of the chemical composition of the solids showed that there were statistically significant differences for some elements among some sample populations. However, these differences are probably small enough to be homogenized during large-scale extraction of the slurry for agricultural or industrial uses. The ASTM-A Water Shake Extraction Procedure and the U.S. EPA Extraction Procedure were used to assess the solubility of slurry samples. Field leachate samples were collected from slurry lagoons at the water treatment plants to provide a basis for comparison with laboratory extracts. Concentrations of several potentially toxic trace substances in the laboratory extracts and field leachates were less than EPA hazardous waste criteria and water quality standards. Solubility modeling of the samples using the computer program WATEQ2 suggested that Ca(2+) activities in the ASTM-A extracts and leachate samples were largely influenced by aragonite solubility.
W85-05385

WASTE DISPOSAL MODELLING,
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
For primary bibliographic entry see Field 5E.
W85-05463

POLLUTING SEWERS BROUGHT UNDER CONTROL,
Marion County Health Dept., Indianapolis, IN. Bureau of Environmental Health.
R. S. Morse, and H. M. Eckrich.
Journal of Environmental Health, Vol. 47, No. 2, p 68-70, September/October, 1984. 4 Fig.

Descriptors: *Marion County, *Indiana, *Water pollution control, *Sewers, Overflows, Combined sewer overflows, Public participation, Public health, Maintenance, Diversion points.

Dry weather overflows from combined sewers have had the potential of creating major public health hazards and of causing environmental damage to seven Marion County, Indiana, streams for many years. On the part of the Health Department the following steps were taken: the setting of goals, objectives, and action plans; a structured approach to monitoring combined sewer overflow points and follow-up of points in violation; systematic reporting to the Department of Pubic Works of flowing points with follow-up or correction; involvement of the public; and the education of public officials responsible for funding and supporting the efforts of the Department of Public Works. The Department of Public Works took the following steps: more frequent monitoring of diversion points; the purchase of new sewer maintenance equipment; more prompt response to reports of overflows, with field reports sent to the Health Department; sewer maintenance at night and on weekends, as needed; securing of manholes that had a history of vandalism; construction of bars across street inlets; personal involvement in supervision; and repairs on particularly tedious diversions with follow-up through frequent walking of these sewers to check 13 otherwise inaccessible diversion points. (Baker-IVI)
W85-05470

APPLYING ANALYTICAL TECHNIQUES TO SOLVE GROUNDWATER CONTAMINATION PROBLEMS,
Drexel Univ., Philadelphia, PA. Environmental Studies Inst.
I. H. Suffet, J. Gibs, J. A. Coyle, R. S. Chrobak, and T. L. Yohe.
Journal of the American Water Works Association, Vol. 77, No. 1, p 65-72, January, 1985. 10 Fig, 9 Tab, 32 Ref.

Descriptors: *Groundwater pollution, *Monitoring, *Water analysis, Drinking water, Water quality control, Chemical analysis, Monitoring, Pollutant identification.

Approaches for analyzing chemical compounds in drinking water are described along with broad spectrum analysis techniques that are effective tools in arriving at optimum methods to treat groundwater contamination. For both broad spectrum analysis and individual compound analysis, the desired range of concentration of contaminants must be selected. Then the objectives of groundwater monitoring can be carried out. Effective groundwater monitoring programs were demonstrated through three case studies. In trace analysis, consistent efficiency of recovery for any compound is generally more important than absolute recovery for quantitative analysis. Consistent efficiency of recovery means that each time an analysis is run, the same percentage of recovery is obtained. Whether the efficiency is 50% or 90%, it must be reproducible. An accurate analysis is aided by consistent efficiency. The key is obtaining consistent data with which to evaluate the problem. Environmental analysis problems include the pitfalls of a large background matrix, sampling bias, and flaws in the measurement system. Quality assurance procedures must be used during environmental sampling to maintain the integrity of the sample. The appropriate method must be used to fit the experimental goal since environmental analysis is still an imperfect science. (Baker-IVI)
W85-05478

HEAVY SNOW LOADS PLAGUE RESERVOIR ROOF,
Culp/Wesner/Culp, Cameron Park, CA.
For primary bibliographic entry see Field 8A.
W85-05482

RIVER QUALITY AND SEWAGE EFFLUENT STANDARDS,
Thames Water Authority (England). Northern Div.
K. Bowden, and D. D. Young.
Journal of the Institute of Water Engineers and Scientists, Vol. 38, No. 6, p 511-527, December, 1984. 1 Fig, 3 Tab, 9 Ref.

Descriptors: *Water quality control, *Water quality standards, *Trent-Severn Water Authority, *Thames Water Authority, *England, Standards, Regulations, Effluents, Planning, Reviews.

Issues affecting management of river water and sewage effluent quality in England since the adoption of the approach to river quality objective and discharge consent conditions proposed by the National Water Council six years ago are examined. Experiences of two water authorities, the Severn-Trent Authority and the Thames Water Authority, which have faced quite different problems during the last decade, are reviewed. Severn-Trent Water Authority is responsible for a variety of river catchments, some of which have suffered grave pollution since the last century. The main features of the river water quality objectives for this area were the complete elimination of the grossly polluted class 4 condition and the upgrading of most of the class 3 rivers to class 2 or better. The situation in the Thames Water Authority was quite different with a much higher proportion of waters of the Thames and Lee catchments being of good quality. There was continuing growth of population, industrial activity and demand in the Thames valley west of London stimulated by factors such as the development of road and air communications and the movement of population away from the metropolis. The determination of standards for each of these authorities is discussed with emphasis on effluent standards for an isolated discharge, multiple discharges, generalized catchment quality models, the River Wey Catchment Quality Review, and extending the approach to private dischargers. For the future, three dominant stimuli for change are expected: the changing economic and political climate, national and international legislation, and innovative thinking by engineers and scientists. (Baker-IVI)
W85-05515

MULTISOLUTE MASS TRANSPORT WITH CHEMICAL INTERACTION KINETICS,

Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W85-05534

BREAKTHROUGH OF BRINE THROUGH COMPACTED FINE GRAINED SOILS,
Windsor Univ. (Ontario). Dept. of Civil Engineering.
K. J. Ridley, and J. K. Bewtra.
In: Proceedings, 38th Industrial Waste Conference, West Lafayette, IN, May 10-12, 1983. Purdue Univ., Butterworth Publishers, Boston, MA. p 879-891, 9 Fig, 8 Tab, 33 Ref.

Descriptors: *Compacted soils, *Brines, *Transport theory, Chlorides, Anions, Seepage, Soil porosity, Path of pollutants, *Groundwater movement.

A study of the breakthrough of brine using a 30% NaCl brine, demonstrated that the use of compacted fine grained soils for containment purposes can minimize but not eliminate the advance of a Cl(-) front. Compaction increases the degree of orientation and aggregation of clay particles, thereby creating a network of smaller sized pores where movement of the solute occurs mainly by diffusion. The tailing phenomenon observed in the breakthrough curves of some of the compacted soils appears to be influenced more by changing pore velocity than unsaturated flow or aggregated media. Anion exclusion is an important factor in increasing the transport of Cl(-) through the soils by 1.79 to 6.38 times than if it had been associated uniformly with all the soil water. The rate of transport of anions through a compacted soil appears to be enhanced by the compaction process. Seepage or convective transport theory is often used to predict breakthrough of a pollutant from a soil mass. If the permeant does not physically or chemically react with the compacted soil, seepage theory can yield false results. Cl(-) concentrations reach terminal breakthrough concentration (TBC) 1.74 to 2.11 times faster than seepage theory predicts, implying that dispersive transport should also be considered. If the rates of breakthrough to TBC are compared using water and brine determined hydraulic conductivity, the water data would underestimate the breakthrough to TBC by as much as 585 times.
W85-05571

EFFECT OF GIBBERELLIC ACID ON THE BUOYANCY OF SPIRODELA INTERMEDIA W. KOCH,
Universidad Nacional del Sur, Bahia Blanca (Argentina). Dept. de Agronomia.
M. G. Klich, M. B. Mujica, and O. A. Fernandez.
Aquatic Botany, Vol. 21, No. 1, p 63-69, January, 1985. 3 Fig, 1 Tab, 14 Ref.

Descriptors: *Plant growth substances, *Gibberellic acid, *Aquatic weed control, *Plant physiology, Aquatic plants, Light intensity, Temperature effects, Herbicides.

Under the environmental conditions of this study 0.1 mg/l of gibberellic acid (GA3) did not affect the growth or buoyance of S. intermedia. Concentrations of 1 and 3 mg/l modified the ability of the fronds to float; an effect influenced by the experimental conditions. When the concentration of GA3 applied was 1 mg/l the percentage of submerged fronds increased from 22 to 62 with increasing light intensity and temperature. At a concentration of 3 mg/l, 57% of the fronds sank at 24 C and 2150 lux and 100% under all the other conditions. Before sinking the plants shed their roots. Concentrations of 1 and 3 mg/l of GA3 reduced both numbers and surface area of fronds. Fresh weights were higher than those of either the 0.1 mg/l of GA3 or control treatments. The differences are statistically significant. When fresh weight per square surface area and the percentage of submerged fronds for each treatment are compared, the higher fresh weight values correlate with numbers of fronds sinking. Plant water content values obtained from fresh and dry weight data, show that increments in total weight were due to an increase in the water content. The air cavities of fronds grown in the presence of GA3 although variable in shape and size were smaller and flatter than those of fronds grown in the absence of the hormone, which were big and tended to be spherical to ovoid in form. Fronds grown in the presence of 1 and 3 mg/l of GA3 had 1-3 fissures on the adaxial epidermis across the distal part, leaving the aerenchyma completely exposed while those grown at 0.1 mg/l of GA3 showed only slight fissure initiation. The action of GA3 may be an effective complement to mechanical control of unwanted aquatic plant species since it is a natural component of the plant mechanism. (Baker-IVI)
W85-05610

CHANGES IN THE QUALITY OF RIVER OISE WATER DURING RETENTION IN THE STORAGE BASIN AT MERY (FRANCE) (EVOLUTION DE LA QUALITE DE LA RIVIERE OISE LORS DE SA RETENTION DANS LE BASSIN DE 'STORAGE' DE MERY (FRANCE)),
Universite Libre de Bruxelles (Belgium). Lab. d'Oceanographie.
For primary bibliographic entry see Field 2H.
W85-05635

INFLUENCE OF RECENTLY DROWNED TERRESTRIAL VEGETATION ON THE QUALITY OF WATER STORED IN IMPOUNDING RESERVOIRS,
Societe Degremont, Rueil-Malmaison (France).
P. C. Mouchet.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1608-1619, December, 1984. 12 Fig, 3 Tab, 32 Ref.

Descriptors: *Reservoirs, *Water quality control, *Vegetation, Decomposing organic matter, Water resources development, Environmental effects, Biochemical oxgyen demand, Chemical stratification.

When an impoundment is filled for the first time, the ecosystem changes from a terrestrial to an aquatic one. Once filled, the terrestrial vegetation dies and decays resulting in chemical stratification. The flooding of meadows will fix in the medium a quantity of dry organic matter of some 2.5 kg/sq m; a European type deciduous forest will fix approximately 50 kg/sq m. The flooding of a forest of 300 t/ha would lead to a BOD5 of some 30 g of oxygen/sq m when only taking into consideration the leaves, branches, bark and litter, sufficient to deprive a water column 3 to 4 m high for 5 days of all oxygen. Over twelve months the quantity of carbon mineralized would be at least 150 to 200 g/sq m, that is an oxygen demand of 400 to 500 g/sq m. The flooding of a meadow of 10 t/ha would result in a BOD of about 5 g/sq m after 5 days, 10 g/sq m after 15 days; over a full year the quantity of C-org mineralized would be some 20 g/sq m that is, an oxygen demand of some 50 g/sq m. The bottoms of reservoirs often are not cleaned because of the high cost of such an operation, but the increase in investment and operating expenses for treating water as a result of its eutrophication makes this preliminary operation worthwhile. In all cases it is imperative to clear all tree vegetation whether standing or not, including stumps and litter. It should not be burnt on site as this leaves phenol compounds and nutrients, which must be completely removed prior to filling. Grassy vegetation can be left, especially if it has only grown after deforesting, if the reservoir can be completely drained at least once several months after storage and if the soil does not require stripping. The soil should be stripped depending on its organic matter and phosphorus content. (Baker-IVI)
W85-05646

USE OF LIME SLURRY FOR DEACIDIFICATION OF RUNNING WATER,
Rogaland Distriktshoegskole, Stavanger (Norway).
H. Abrahamsen, and D. Matzow.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1981-1985, December, 1984. 3 Fig, 8 Ref.

Descriptors: *Water treatment, *Norway, *River Vaaraana, *Lime slurry, *Deacidification, Water quality control, Lakes, Rivers, Lime, Toxicity, Mortality, Trout, Salmon.

In southern and western parts of Norway, the precipitation and runoff are extremely high, while the lakes are small with a short water retention time. This makes it uneconomical to lime the lakes, and therefore it is important to find methods for liming running water. A description is offered of a lime slurry dosing system used in the River Vaaraana (Norway) to help combat acidification of rivers. The catchment is 33.5 sq km and average runoff is 50 l/second/sq km. The catchment upstream of the dosing system is 18.5 sq km. Experiments were conducted with one summer old fingerlings of Atlantic salmon and sea trout exposed in the river. The fish were kept in keepnets with a volume of 40 L and placed in wood ploughs in the river. No mortality downstream of the point of liming occurred during the experiment. Upstream of the point of liming, the mortality reached 85% for sea trout and 90% for salmon within 120 hr. (Baker-IVI)
W85-05679

RECLAMATION OF THE PEARL RIVER, A PERSPECTIVE OF UNPOLLUTED VERSUS POLLUTED WATERS,
Tulane Univ., New Orleans, LA.
G. E. Gunning, and R. D. Suttkus.
Fisheries, Vol. 10, No. 1, p 14-16, January-February, 1985. 3 Fig, 1 Tab, 2 Ref.

Descriptors: *Water pollution control, *River reclamation, *Pearl River, *Louisiana, Wastewater treatment, Water quality control, Fish, Invertebrates, Mussels, Annelids.

Historically the Pearl River (Louisiana) received large amounts of municipal sewage and industrial wastes. The river was ultimately reclaimed by installation of primary and secondary treatment facilities for both effluents. No violations of state or federal water quality criteria were observed in the 10-year period subsequent to installation of treatment facilities. Positive results of pollution abatement and river reclamation were: (1) an increase in clean water species of fishes and invertebrates, (2) a decrease in pollution tolerant species such as the annelid Tubifex, (3) reestablishment of unionid mussel populations in the reclaimed river segment, and (4) increased growth rate for some species of fishes. (Author's abstract)
W85-05725

VARIATIONS IN QUALITY IN THE GANGES,
Roorkee Univ. (India). Dept. of Civil Engineering.
D. S. Bhargava.
Effluent and Water Treatment Journal, Vol. 25, No. 2, p 61-65, February, 1985. 2 Fig, 1 Tab, 12 Ref.

Descriptors: *Water quality control, *India, *Ganges, Temperature effects, Industrial wastes, Domestic wastes, Drinking water, Public health, Safety, Sanitation.

The water quality of the Ganges (India) undergoes significant changes due to seasonal effects, confluence with tributaries, and entry of wastewaters. The lower temperature in the upstream stretches attains equilibrium with the ambient temperature. The upswing in the river's temperature indicates the wastewater outfall points. The clarity of the river is higher in the upland parts of the river in winter months. At waste outfall points, the decreased clarity improves because of the bioflocculation. The clarity of the river cannot be used as an indicator of pollution of the river unless the BOD is also determined. The BOD of the river was greater in summer months due to a decreased flow in the river. The ground water quality influence on the river quality was noted from such variables as conductivity, chlorides and hardness. Coliforms increased at wastewater outfall points but their concentration is reduced within short distances due to flocculation. There is an urgent need for pollu-

tion control in the river for the safety of people who drink the water at various places. (Baker-IVI)
W85-05836

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

SAGE: A NEW PARTICIPANT-VALUE METHOD FOR ENVIRONMENTAL ASSESSMENT,
Appropriate Technology International, Washington, DC.
E. L. Hyman, D. H. Moreau, and B. Stiftel.
Water Resources Bulletin, Vol. 20, No. 6 p 915-922, December 1984. 5 Tab, 26 Ref. U.S. Department of the Interior, Office of Water Research and Technology project 13-34-8408.

Descriptors: *Environmental assessment, *Decision making, *Model studies, *Attitudes, Public opinion, Policy making, Social participation, Social values.

A novel participant-value method for environmental assessment, called SAGE, was developed which has application in evaluating land use/watershed management problems. SAGE stands for Social Judgment Capturing-Adaptive-Goals Achievement-Environmental Assessment and follows the strategy of social judgement theory by inferring value weights back from the choices that people make on a series of alternatives. Additionally, SAGE yields a measure of each participant's assignment of the value weights. These weights are applied to scaled scores for accounts based on measurable attributes of each objective. In order to indicate the political ramifications of decisions and to facilitate sensitivity analysis, the values held by various groups are presented in matrix form arrayed by group affiliation or by judgment types that share common values. Physical, chemical and biological attibutes of alternative action are predicted and scaled into accounts of beneficial and adverse effects on the objectives. SAGE was tested in a practical problem concerning alternative urban development patterns for the Falls of the Neuse Watershed in Piedmont, North Carolina. This preliminary test indicates that with a modest expenditure of time and resources, SAGE can facilitate participation by the public and by decision makers. It is applicable to either specific project analyses or regional planning studies. SAGE clearly separates facts from values in its scaling and weighting procedure. It recognizes the diversity of values held by different groups through its presentation of a cross-tabulated matrix of impacts and value weights. This information helps decision makers understand the sources of agreement and conflict so that a consensus can be built around possible modifications of the proposed project. (Collier-IVI)
W85-04999

MEASURING THE SITE-SPECIFIC RECREATION BENEFITS RESULTING FROM IMPROVED WATER QUALITY: AN UPPER BOUND APPROACH,
Pittsburgh Univ., PA. Dept. of Economics.
J. Ochs, and R. S. Thorn.
Water Resources Bulletin, Vol. 20, No. 6, p 923-927, December, 1984. 2 Fig, 9 Ref.

Descriptors: *Recreation, *Water quality, *Benefits, Cost-benefit analysis, Economic aspects, Public policy.

The estimation of the value of recreation benefits resulting from improved water quality is required for many purposes. In particular, the Water Pollution Control Act of 1980 requires the consideration of the reasonableness of costs of reducing water pollution in relation to benefits to be derived from establishing effluent standards (Clean Water Act of 1977). Recreation is often the most important benefit resulting from water quality improvement. Current methods used to calculate recreation benefits are either not site-specific or are expensive and controversial. A relatively simple, inexpensive, and less controversial method of calculating site-specific recreation benefits resulting from improved water quality was developed. The method produces an upper bound estimate which often is adequate for the relevant decision. The upper bound estimates is based on two assumptions: 1) there are alternative equivalent substitute sites for the newly augmented water quality site, and 2)the new augmented recreation opportunities at the site will be used to their maximum supply capacity. Clearly, if an upper bound benefit estimate in a cost-benefit ratio does not produce a favorable ratio, no other benefit estimate will. In cases where this estimate produces an ambiguous result resort must be had to other more precise methods of estimation. (Author's abstract)
W85-05000

PROSPECTS OF USING AUTOMATED MANAGEMENT SYSTEMS IN EARTH-DAM CONSTRUCTION,
For primary bibliographic entry see Field 8A.
W85-05022

MICROSYSTEM SEDIMENT-WATER SIMULATION STUDY FOR THE PROPOSED JORDANELLE RESERVOIR, HEBER CITY, UTAH,
Bureau of Reclamation, Denver, CO. Applied Sciences Branch.
For primary bibliographic entry see Field 5B.
W85-05305

PROGRAM MANAGEMENT KEEPS ANCHORAGE WATER PROJECT ON SCHEDULE,
Montgomery (James M.), Inc., Pasadena, CA.
W. H. Blackmer, and R. E. Smith.
Public Works, Vol. 116, No. 8, p 49-51, January, 1985. 2 Fig.

Descriptors: *Planning, *Water resources development, *Anchorage, *Alaska, Decision making, Planning, Eklutna Water Project, Water conveyance, Water supply, Water treatment facilities.

Anchorage is among the fastest growing municipalities in the country. After extensive studies of 28 alternative sources for a supplemental water supply, it was concluded that the most cost-effective, long-term source is Eklutna Lake, located 35 miles from downtown Anchorage. The Eklutna Water Project has a lake diversion through a tunnel 7,000 ft long, 7 miles of 54 in raw water transmission main, two energy recovery stations, a 35 mgd water treatment facility, and 15-MG clearwell-reservoir, and 22 miles of large diameter potable water transmission main. State appropriated funds will cover 75% of the project. The remaining 25% is from municipal general obligation bonds, approved by voters in 1983 by a 3:1 margin. Five different types of project management systems have been considered. In the plan finally chosen with only a few exceptions, the program management team performs all project tasks including planning, surveying, geotechnical, preliminary engineering, environmental, permitting, public education, and construction management services and operator training. The municipality has kept control over the bidding process through its purchasing division. (Baker-IVI)
W85-05486

INTERACTIVE COMPUTER MODELING FOR POLICY ANALYSIS; THE FLOOD HAZARD PROBLEM,
Wharton School, Philadelphia, PA. Dept. of Decision Sciences.
H. Kunreuther, and L. Miller.
Water Resources Research, Vol. 21, No. 2, p 105-113, February, 1985. 3 Fig, 3 Tab, 18 Ref.

Descriptors: *Floods, *Computer models, *Policy making, Decision making, Computers, Model studies, Flood control, Flood damage.

An interactive modeling system is discussed which is designed to support policy analysis for dealing with flood hazards. Policy analysis in this area is complex due to numerous stakeholders with varying concerns, the variety of scenarios that might be considered, and alternative policy options. These conditions argue that a modeling system be flexible and support users in a variety of ways. The system should be viewed as a decision aid rather than a burden. The modeling system described (Wharton Interactive Modeling System WHIMS) attempts to achieve these goals for microanalytic models that deal with samples of homeowners in a flood prone community. (Baker-IVI)
W85-05490

INTERACTIVE COMPUTER TECHNOLOGY FOR PLANNING AND POLICY MODELING,
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
K. Fedra, and D. P. Loucks.
Water Resources Research, Vol. 21, No. 2, p 114-122, February, 1985. 7 Fig, 52 Ref.

Descriptors: *Planning, *Decision making, *Water resources development, *Computers, Policy, Regulations, Computer models.

Computer assisted methods of planning and design, information management, and process control have proven to be highly successful, and once implemented, indispensible in numerous fields of application. The potential impacts of increasing access to and use of computer technology and communication are considered, especially with respect to water resources and environmental planning and policy making. The discussion focuses on the interaction between the users of this expanding technology and the technology itself. Specific topics include symbolic interfaces for man-machine interaction, and a display-oriented user interface. (Baker-IVI)
W85-05491

INTERACTIVE DATA MANAGEMENT FOR RESOURCE PLANNING AND ANALYSIS,
Cornell Univ., Ithaca, NY. Dept. of Civil and Environmental Engineering.
D. P. Loucks, M. R. Taylor, and P. N. French.
Water Resources Research, Vol. 21, No. 2, p 131-142, February, 1985. 26 Fig, 16 Ref.

Descriptors: *Water resources development, *Computers, *Data management, *Planning, Evaluation, Decision making.

A number of research projects at Cornell University have focused on the development and application of interactive models and computer programs for studying water resources and environmental management problems. These models and programs have been adapted for use with computer graphic display devices. This interactive computer aided planning system has been designed to facilitate data input, editing, and display; model building and solution; and analysis and synthesis of alternative resource management plans or policies. Approaches taken for managing and displaying data that are needed for, and derived from, this interactive modeling system are discussed. Several applications are presented and some conclusions on how such systems might be developed or expanded in the future are proposed. (Baker-IVI)
W85-05493

MODULAR INTERACTIVE SIMULATION SYSTEM FOR EUTROPHICATION AND REGIONAL DEVELOPMENT,
Minnesota Univ., Minneapolis. Dept. of Agricultural and Applied Economics.
For primary bibliographic entry see Field 5C.
W85-05494

6B. Evaluation Process

EVALUATION OF ALTERNATIVE POLICIES FOR CONTROLLING AGRICULTURAL NONPOINT SOURCE POLLUTION,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
R. A. Kramer, W. T. McSweeny, W. R. Kerns, and R. W. Stavros.

Water Resources Bulletin, Vol. 20. No. 6, p 841-846, December, 1984. 2 Tab, 11 Ref.

Descriptors: *Nonpoint pollution sources, *Agricultural runoff, *Economic aspects, *Costs, *Watershed models, *Nansemond River Watershed, *Chuckatuck Creek Watershed, *Virginia, *Water pollution control, Model studies, Public policy, Runoff, Best management practices, Rural Clean Water Program, Cost sharing, Agricultural Conservation Program.

The potential effectiveness of public policy actions for reducing nonpoint source pollution was examined with an economic analysis of nonpoint source pollution management for the Nansemond River and Chuckatuck Creek watersheds in Southeast Virginia. Parts of these watersheds are included in the Rural Clean Water Program (RCWP); water quality in the area is poor, as is characteristic of many tributaries of the Chesapeake Bay. The potential effects of alternative public policies on farm income, land use, and pollution loadings were investigated. A linear programming model of the Nansemond and Chuckatuck watersheds was constructed which focused on the relationships among agricultural land use practices and nonpoint source pollution. Using statewide enterprise budgets as guidelines, area specific crop and livestock budgets were developed. Cost data for the best management practices (BMPs) were included in the model. Regulatory programs could have quite different impacts depending on which pollutant is targeted. A program with explicit water quality goals like the RCWP could have a different impact on land use practices than a program like the Agricultural Conservation Program which has a primary goal of maintaining soil productivity. The regulatory approaches, while effective in reducing pollution, decrease net farm income in the watersheds; in no case do the reductions exceed 4% of base line income. Even income declines of this magnitude could have severe impacts on farmers, particularly during periods of financial stress for agriculture. Cost-share alternatives appear effective in reducing pollutant loadings and have the political advantage of raising net farm income. Cost-share rates greater than 50 percent would have little additional effect on generated soil, nitrogen, or phosphorus from crop enterprises, but would reduce pollution from livestock. (Collier-IVI)
W85-04989

NEW HAMPSHIRE WATER SYSTEMS: ENVIRONMENTAL AND OWNERSHIP CONSIDERATIONS,
New Hampshire Univ., Durham. Dept. of Resource Economics and Community Development.
B. E. Lindsay.
Water Resources Bulletin, Vol. 20, No. 6, p 901-904, December, 1984. 2 Tab, 5 Ref. New Hampshire Agricultural Experiment Station project H-294.

Descriptors: *New Hampshire, *Water distribution, *Utilities, *Ownership, Water treatment facilities, Privatization, Costs, Economic aspects.

To investigate the ownership effect upon consumer costs for an industry located in New England, an evaluation of municipal or publicly-owned water utilities and privately owned water firms located in New Hampshire was carried out. Managerial, facility, and distributional information was available for approximately 120 water systems with the data for 78 systems (61 public, 17 private) was usable. A linear multiple regression econometric model was developed to measure the influence of several environmentally oriented variables and an ownership variable upon the average total residential water costs for New Hampshire water systems. The implementation of leak detection programs and localized institutional rules and regulations increased the residential water costs. Hazardous waste inspection programs decreased residential water costs. The existence of a water conservation program did not statistically influence these per unit costs. Water systems that were privately owned resulted in per unit costs that were higher relative to firms that were publicly owned. New Hampshire municipalities that are considering privatizing their presently publicly-owned water systems should make careful evaluation of the resulting costs of such a changeover; privatizing of New Hampshire water systems may not be an economically sound policy. (Collier-IVI)
W85-04997

ANATOMY OF THE GORDON-FRANKLIN (TASMANIA) DAM CONTROVERSY; SOCIO-ECONOMIC, POLITICAL AND ENVIRONMENTAL IMPLICATIONS - A VIEWPOINT,
Tasmania Univ., Hobart (Australia). Environmental Studies.
K. N. Baidya.
International Journal of Environmental Studies, Vol. 23, No. 3/4, p 283-301, October, 1984. 1 Fig, 5 Tab, 31 Ref.

Descriptors: *Social aspect, *Economic aspects, *Environmental effects, *Gordon-Franklin Dam, *Tasmania, *Australia, Legislation, Public participation, Political factors, Conservation, Dams, Environmental policy.

South-West Tasmania is one of the last three great wilderness areas of the Southern temperate regions of the world. There are obvious justifiable reasons for the area to be kept preserved for posterity. The Tasmanian conservation group or ecoactivists have been able to open public debate on the South-West dam issue in recent times, through lobbying, challenging, project evaluation methodologies and even seeking judicial redress. Despite the institution of so many investigation mechanisms like select committees, public debates, Legislative Council committees, the referendum, and parliamentary election, the net result was a zero sum game. Tasmania has the potentialities not only to guide Australia but the whole world in the conservation movement. What she needs is to come out of the so called economic mad rush or rat race. A new dimension must be added to the mere economic problems. This is only possible if and when there is total conceptual change or reorientation of the present political system of Tasmania. (Baker-IVI)
W85-05034

AGRICULTURAL WATER POLLUTION CONTROL: AN INTERDISCIPLINARY APPROACH,
Max C. Fleischmann Coll. of Agriculture, Reno, NV.
W. W. Miller, C. T. K. Ching, J. F. Yanagida, and P. Jakus.
Environmental Management, Vol. 9, No. 1, p 1-6, January, 1985. 7 Tab, 19 Ref.

Descriptors: *Agricultural runoff, *Water pollution control, *Economic aspects, Costs, Alfalfa, Model studies.

Regulation and control of agricultural water pollution is unique and difficult to accomplish. Water quality standards are often proposed without adequate consideration of the overall economic impact on agricultural production. This article illustrates how economists and physical scientists can cooperate to develop appropriate control strategies for agricultural water pollution. Data provided by physical scientists and economists are used in a linear programming model to describe salt discharge as a function of water management, production levels, and an associated effluent charge. Four water management activities were chosen on the basis of different costs of production (including a parametrically varied effluent charge), water requirements, alfalfa yields, and levels of salt discharge. Results indicate that when the effluent charge is low ($< $0.20/metric ton salt discharged), maximum production with maximum salt discharge is most profitable. As the effluent charge is increased ($0.20-$0.40/metric ton salt discharged), it becomes progressively less profitable to produce alfalfa at maximum levels of pollutant discharge. When the effluent charge is $> $0.40/metric ton salt discharge, alfalfa production is no longer economically feasible. An important aspect of this approach is that it permits policy makers to identify explicitly the relationship between the environmental standard and the effect on agricultural production. (Author's abstract)
W85-05067

DOES YOUR WATER SYSTEM HAVE HYDROELECTRIC GENERATING POTENTIAL,
Boulder City Manager, CO.
R. L. Wheeler, P. Wrenn, and B. Grant.
Public Works, Vol. 116, No. 2, p 70-74, February, 1985. 3 Fig, 1 Tab.

Descriptors: *Water resources development, *Water conveyance, *Hydroelectric power, *Boulder, *Colorado, Power, Energy, Turbines, Pipelines, Cost analysis.

Many water systems in the Rocky Mountain region take advantage of gravity water flow in supply lines from a water source to a treatment plant; water often arrives at the plant under high pressure, which must be reduced to near zero for treatment plant processes. Boulder, Colorado recognized the energy potential inherent in the raw water pipeline system in 1980. A feasibility study was undertaken to determine the best sites for power production, the most efficient types and sizes of hydroelectric equipment for those sites, the costs and paybacks involved, and the effects that such facilities would have on the primary purpose of the water utility: supplying water for a municipal water system. Boulder is taking advantage of wasted pressure in its raw water supply and distribution system. Some ten sites have been identified where pressure reducing valves could be replaced with hydroelectric turbines. (Baker-IVI)
W85-05488

INTERACTIVE WATER RESOURCES MODELING AND MODEL USE: AN OVERVIEW,
Cornell Univ., Ithaca, NY. Dept. of Civil and Environmental Engineering.
D. P. Loucks, J. Kindler, and K. Fedra.
Water Resources Research, Vol. 21, No. 2, p 95-102, February, 1985. 14 Fig, 26 Ref.

Descriptors: *Water management, *Model studies, *Water resources development, Reviews, Computers, Planning, Policy making.

Important short comings of many management and policy models are reviewed and improved human-computer-model interaction and communication is encouraged. If models are to be increasingly used, it is felt that models must be easy to use, easy to understand, and must be adaptive to a wide variety of possible policy alternatives. The increasing availability and use of time sharing computer networks, microcomputers, and interactive computer languages make it possible for most to have access to fast, inexpensive, interactive computing power, supplemented increasingly by color display capabilities if desired. As the first in a series of articles on interactive modeling for water resource and environmental planning and policy making, it is argued that such an approach might lead to more effective modeling and model use. (Baker-IVI)
W85-05489

VAST DIVERSION OF SOVIET RIVER,
For primary bibliographic entry see Field 6G.
W85-05767

APPROXIMATE METHOD FOR THE ANALYSIS OF UNCERTAINTY IN BENEFIT-COST RATIOS,
Adelaide Univ. (Australia). Dept. of Civil Engineering.
G. C. Dandy.
Water Resources Research, Vol. 21, No. 3, p 267-271, March, 1985. 3 Fig, 3 Tab, 9 Ref.

Descriptors: *Statistical analysis, *Uncertainty, *Cost-benefit analysis, *Economic evaluation, Benefits, Project planning, Decision making, Water resource development.

An economic comparison of projects should take uncertainty in benefit-cost ratios into account; a risk-averse decision maker may well prefer project A, which has less uncertainty in its B/C ratio to project B, which has a higher expected B/C ratio but a much greater uncertainty. No complete methodologies exist for treating the problem of

uncertainty in the estimates of benefits and costs for any proposed water resource project. An approximate procedure for uncertainty estimation was developed which does not require the use of a computer but which gives answers which are reasonable given the precision of the underlying data. The method is based on subjective estimates of 'most likely,' 'upper,' and 'lower' values for individual components of benefits and costs and estimates of the correlation coefficients between these components. The main errors introduced by the approach are relatively small. A case study demonstrated application of the method. (Collier-IVI)
W85-05789

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

NEW HAMPSHIRE WATER SYSTEMS: ENVIRONMENTAL AND OWNERSHIP CONSIDERATIONS,
New Hampshire Univ., Durham. Dept. of Resource Economics and Community Development.
For primary bibliographic entry see Field 6B.
W85-04997

ENGINEERING ECONOMIC ANALYSIS OF A PROGRAM FOR ARTIFICIAL GROUNDWATER RECHARGE,
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 4B.
W85-05001

IMPLEMENTATION OF A USER CHARGE SYSTEM INCORPORATING A DEDICATED AD VALOREM TAX STRUCTURE,
Metropolitan Sanitary District of Greater Chicago, IL.
H. A. Smith, J. T. Fornek, and C. Lue-Hing.
In: Proceedings, 37th Industrial Waste Conference, West Lafayette, IN, May 11-13, 1982. Purdue Univ., 1983. p 577-589. 8 Fig, 2 Tab, 1 Ref.

Descriptors: *Taxes, *Tax rates, Sewer systems, Chicago, Clean Water Act, Federal Water Pollution Control Act, Ad valorem taxes, User charges.

The Metropolitan Sanitary District of Greater Chicago is charged with the principal responsibility of collection, treatment and disposal of sewage in the Chicago metropolitan area. Regulations promulgated under the Federal Water Pollution Control Act Amendments of 1972 and the Clean Act of 1977 require that the district administer a system of revenue collection to recover the costs of operation, maintenance and replacement of the district's facilities associated with the collection and treatment of sewerage, and the handling and disposal of solids removed in the treatment process. The residential users are not affected because they continue to pay their User Charge through ad valorem taxes. Commercial and Industrial users are subject to the requirements of the district's self assessing reporting system. Under this system all Commercial and Industrial users must file a certified classification statement. Those Commercial and Industrial users that are small users are classified with residential users. There are no additonal requirements under the self assessing program. However, if their operation changes in such a way that these users are subject to reclassification, a new certified classification statement submittal is required. Users in the Tax Exempt class are dramatically affected because prior to the User Charge Ordinance these users did not pay for wastewater treatment services.
W85-05277

COST SHARING FOR FEDERAL WATER PROJECTS: TRENDS AND IMPLICATIONS,
Minnesota Univ., Minneapolis. Dept. of Agricultural and Applied Economics.
J. J. Waelti.
Water Resources Research, Vol. 21, No. 2, p 153-158, February, 1985. 3 Tab, 15 Ref.

Descriptors: *Federal Water Projects, *Cost sharing, Cost analysis, Financial aspects, Planning, Evaluation, Political aspects, Policy.

Major water policy events beginning with the 1950's are reviewed with respect to their bearing on proposed changes in the much criticized federal policies for nonfederal cost sharing. The cost sharing proposals of the Carter and Reagan administrations are reviewed. These proposals are discussed with respect to theoretical economic efficiency and political equity. Both sets of proposals represented improvements over the traditional system. Both were defeated because of political opposition. The natural of federal water projects may be such that there are political advantages in the existing system for both the executive and legislative branches of government. One such advantage is that water projects are in many respects convenient media for the exchange of votes. While Congress can appropriate any sum of money for any project it wishes, the Administration can make life easy or difficult for the congressional representatives of any given region by including, or not including, funds for a given project in the president's budget message. Innovations such as an independent agency for project evaluation, or cost sharing on a beneficiary pays basis, may be seen by both the legislative and the executive branches of government as reducing the options for vote trading to attain broader national objectives. (Baker-IVI)
W85-05495

ADAM'S TEARS TURNED TO ELECTRICITY.
New Scientist, Vol. 105, No. 1443, p 14-16, February, 1985. 5 Fig.

Descriptors: *Water resources development, *Hydroelectric power, *Sri Lanka, Powerplants, Dams, Planning, Irrigation, Water supply.

Sri Lanka is trying to construct a massive hydroelectric and irrigation scheme in seven years instead of the expected 30. Success could see the country self-sufficient in power as well as in food. Sri Lanka's economy has been devastated by high oil prices with unofficial estimates placing the rate of unemployment at close to 20%. With a considerable amount of foreign expertise, Sri Lanka began to exploit the potential of the Mahaweli River at an increasing rate. The complex of dams, hydropower stations and irrigation networks now being built should nearly double the country's installed capacity from 562 megawatts to 1070 megawatts. Three countries, Britain, Sweden and West Germany, are the most substantial foreign investors. The development of the river and its tributaries is based on an elaborate system of channels, holding reservoirs, dams and hydropower stations. The intention is to use the drop or head of the Hamaweli to generate hydroelectric power at a number of sites along its length. In some cases the water is intended only for irrigation, in others, for both irrigation and power. (Baker-IVI)
W85-05522

ALGORITHM FOR MIXING PROBLEMS IN WATER SYSTEMS,
RMM Technical Services, Inc., Cincinnati, OH.
R. M. Males, R. M. Clark, P. J. Wehrman, and W. E. Gates.
Journal of Hydraulic Engineering, Vol. 111, No. 2, p 206-219, February, 1985. 8 Fig, 3 Ref, 1 Append.

Descriptors: *Algorithms, *Mathematical equations, *Water distribution, *Mixing, Costs, Model studies, Economic aspects, Hydraulics.

The 'Solver' algorithm, developed as an outgrowth of work on cost allocation in water distribution systems, is a simple technique that solves a number of interesting problems in water distribution system analysis. Problems related to mixing water from different sources within the distribution network, travel time from any source to any node of the network, and development of the cost of service to any node in the network can be solved assuming steady-state conditions, given a prior solution of the hydraulics (flow in each link) of the network. All these problems are formulated as the solution of simultaneous linear equations. The Solver algorithm has been coded in Fortran and incorporated within the structure of a multi-purpose system of computer programs that allows for the storage, display and manipulation of data associated with node-link networks describing water distribution systems. These programs are identified by the name Water Supply Simulation Model. The formulation of the Solver algorithm is described in detail, with examples of its use. (Author's abstract)
W85-05780

MULTIPURPOSE CRITERIA OF SELECTING THE METHOD OF REGULATING THE DELIVERY OF PUMPING STATIONS OF A WATER-SUPPLY CANAL,
L. M. Shtabskii.
Hydrotechnical Construction, Vol. 18, No. 7, p 317-321, July, 1984. 7 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 31-34, July, 1984.

Descriptors: *Pumped storage, *Water management, *Water delivery, Canals, Water supply, Optimization, Multipurpose projects, Water conveyance.

The method of regulating the water delivery of pumping stations of a water supply canal, which in the general case represents a cascade of pumping stations and pressure and open stretches, affects both the capital expenditures for the main structures and the main technical and economic indices during operation. In some cases, the energy savings on pumping water is used for an approximate calculation of the effectiveness of various regulating methods, which reflects only one, albeit the most important, parameter when comparing different variants. The linear economic-mathematical model is a widespread method of solving the problem of selecting the optimal regulation method. Of particular interest are methods of evaluating variants of regulating the delivery of large water management canals founded on a heuristic base. For complex multipurpose systems, when analyzing delivery regulation variants it is possible to use the method of mutipurpose optimization. The most important stage of solving the problem by the multipurpose optimization method is a determination of the sets of goals, which express the direct expenditures of various resources for realization of the regulating system and determine the consumer properties of the entire canal obtained on using the variants of regulation being compared. The composition of goals for a particular water management system should reflect the objective conditions of its functioning and also those management problems which are determined for the system by a higher level. (Baker-IVI)
W85-05824

ECONOMIC ASPECTS IN THE INVESTIGATION OF GROUND-WATER CONTAMINATION EPISODES,
Haifa Univ. (Israel).
For primary bibliographic entry see Field 5C.
W85-05840

6E. Water Law and Institutions

CALCULATING REFERENCE LEVELS FROM MAXIMUM LEVELS (BEZUGSWERT-ERRECHNUNG AUS HOCHSTWERTEN).
Wasser, Luft und Betrieb, Vol. 27, No. 12, p 24, December, 1983.

Descriptors: *Germany (Federal Republic), *Taxes, *Wastewater taxes, Legal aspects, Water pollution control, Monitoring.

The question of whether wastewater-tax laws in the Federal Republic of Germany provide for the calculation of reference levels of pollutants in wastewater from maximum levels agreed upon by the parties involved or prescribed by state water law rather than by actual measurement is addressed. Neither state wastewater-tax laws nor administrative rules deal with the question directly. Both federal law and administrative rules in the states of Hessen and Rheinland-Pfalz indicate that

control levels must be derived from actual measurement. The Hessen rules recognize that provisional levels must be worked with when insufficient data exist to calculate a statisticaly valid mean, but stipulate that the data base must then be improved through increased monitoring and control. The state government of Nordrhein-Westfalen addresses the question of the use of measured values under the threshold of statistical validity by stating that such data may not be used to prove that a standard of 1 kg Hg/yr has been met. Since control levels are only acceptable if derived from measurement, it follows that maximum levels must also be so derived. Reference levels calculated by halving fictitious maximum levels are therefore not permissible. Levels used in monitoring can be set independently of wastewater-tax law but should also be statistically valid so that they can be controlled. (Gish-IVI)
W85-05138

TIGHTENING REGULATIONS FOR HAZARDOUS WASTE MANAGEMENT: MANDATES AND COMPLIANCE STRATEGIES,
Jacobs Engineering Group, Inc., Pasadena, CA.
S. W. Kahane, S. L. Phinney, and A. P. Wright.
Chemical Engineering Progress, Vol. 81, No. 3, p 11-15, March, 1985.

Descriptors: *Regulations, *Hazardous material, *Waste disposal, Resource Conservation and Recovery Act, Comprehensive Environmental Response, Compensation and Liability Act, Clean Water Act, Clean Air Act, Legislation, Waste management, Water quality control.

As the EPA and the states move to a more aggressive program of inspection and enforcement, it is vital that industries take the initiative to protect themselves against unanticipated public exposure and cleanup costs. A case history is presented of a firm that operated within the law in the past but found that current regulations consider past and ongoing disposal practices no longer in compliance. Details are offered of the Resource Conservation and Recovery Act (RCRA). Section 3001 requires the EPA to establish criteria for identifying hazardous wastes. Regulations applicable to generators of hazardous waste are established under Section 3002. Sections 3003 through 3006 regulate hazardous waste transport, treatment, storage and disposal. Subtitle D of the RCRA addresses the management of nonhazardous solid waste. Other key regulations include the Comprehensive Environmental Response, Compensation and Liability Act, the Clean Water Act, Clean Air Act, and the Toxic Substances Control Act. (Baker-IVI)
W85-05768

ORGANICS, PLASTICS, AND SYNTHETICS INDUSTRY DISCHARGE: PERFORMANCE AND REGULATIONS,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
R. A. Reich, and H. J. Campbell, Jr.
Chemical Engineering Progress, Vol. 81, No. 3, p 16-21, March, 1985. 3 Tab, 15 Ref.

Descriptors: *Waste disposal, *Regulations, *Organic compounds, *Plastics, *Industrial wastes, Synthetics industry, Water quality control, Water pollution control.

In March 1983, the EPA proposed Effluent Limitations Guidelines and Standards for the Organic Chemicals and Plastics and Synthetic Fibers (OCPSF) Point Source category. The progress made to date by the OCPSF industry has been substantial for both conventional and priority pollutants, despite the absence of federal guidelines for the industry. Evidence shows that the OCPSF industry discharges, under control through BPJ/BPT (Best Professional Judgement/Best Practicable Control Technology) permit determinations, are not a national problem. In fact, the current discharge of priority pollutants by this industry is well below the level EPA projected following BAT (Best Available Technology) implementation. In light of this progress and the unrealistic BAT levels proposed by the EPA, it is felt that the final OCPSF effluent guidelines need to be more rational and cost effective. (Baker-IV)
W85-05769

AMENDING THE WATER ACT - FRAMING THE ISSUES FOR DEBATE,
B. Ward.
Environmental Forum, Vol. 3, No. 10, p 18-21, February, 1985.

Descriptors: *Clean Water Act, *Political aspects, *Legislation, Federal jurisdiction, Water quality control, Planning, Decision making, Permits, Nonpoint source pollution.

The Clean Water Act is due for reauthorization. Some aspects of the Act have changed. Authorizations are expiring this year for the Title II sewage treatment construction grants program. Construction grants funding this year will be the impetus for congressional amendments. Funding for Title II will be viewed within the context of the need to reduce public expenditures. In addition to determining just how long the grants program will continue, how it will be phased out, and what precise levels of funding should be, Congress of course will have to take on the always highly political step of choosing how the federal funds will be allocated or allotted to individual states. Another issue that is likely to arise in the reauthorization effort this year is a proposal to extend national Pollutant Discharge Elimination System (NPDES) permits from 5 to 10 years, with a reopener. As in the last Congress, the issue of nonpoint source pollution control is likely again to be considered as part of the reauthorization effort. Also intense will be the debate on interstate dispute resolution issues and the related issue of preserving other state rights or federal common law. (Baker-IVI)
W85-05833

6F. Nonstructural Alternatives

DISTRIBUTION OF ECONOMIC RENTS WHEN IRRIGATED FARMLAND IS LEASED: THE CASE OF THE IMPERIAL VALLEY, CALIFORNIA,
California Univ., Davis. Dept. of Agricultural Economics.
B. D. Gardner, and R. G. Huffaker.
Available from the National Technical Information Service, Springfield, VA 22161. Final Report, September 30, 1983. 93 p, 7 Fig, 22 Tab, 21 Ref. Contract/Grant No. 1-07-81-V0201.

Descriptors: *Farms, *Leases, *Economic rent, Public policy, *Irrigation, Economic aspects.

A method of testing whether unrestricted leasing of farmland in federal water projects concentrates the distribution of economic rents is proposed. The Imperial Valley, California, was the reclamation area chosen for the study. A survey was taken from 25 tenants participating in 156 cash leases and 45 share leases. The economic rents which each tenant could likely expect were calculated from the survey data, amortized, and compared to the annual rental rates actually paid to landowners (in the case of cash leases), or to the annual expected share rents each tenant was calculated to anticipate paying landowners (in the case of share leases). The percentages of expected rents paid by tenants to landowners, calculated from the cash and share lease studies, do not support the hypothesis that unrestricted leasing in the sample reclamation area is concentrating economic rents in the hands of the larger tenants, and tenants holding family leases. The percentages of expected rents paid by tenants to landowners, calculated from the cash and share leases studied, show the lease market in the study reclamation area to be a fairly efficient and competitive market. The data suggest that most of the economic benefits generated by water subsidies are going to landowners, not tenants. It does not appear that the rents are being disproportionately captured by the larger tenants. There is no correlation in the percentage of total expected rents paid by tenants and their scales of operation. Tenants holding family leases pay a slightly lower than average portion of their expected rents, with 85 percent going to landowners in family cash leases and 74 percent in family share leases.
W85-05330

6G. Ecologic Impact Of Water Development

ANATOMY OF THE GORDON-FRANKLIN (TASMANIA) DAM CONTROVERSY: SOCIO-ECONOMIC, POLITICAL AND ENVIRONMENTAL IMPLICATIONS - A VIEWPOINT,
Tasmania Univ., Hobart (Australia). Environmental Studies.
For primary bibliographic entry see Field 6B.
W85-05034

METALS AND CHLORINATED HYDROCARBONS IN SURFICIAL SEDIMENTS OF THREE NILE DELTA LAKES, EGYPT,
Alexandria Univ. (Egypt). Dept. of Oceanography.
M. A. H. Saad, S. R. McComas, and S. J. Eisenreich.
Water, Air, and Soil Pollution, Vol. 24, No. 1, p 27-39, January, 1985. 4 Fig, 5 Tab, 34 Ref.

Descriptors: *Lake sediments, *Chlorinated hydrocarbons, *Metals, *Egypt, *Nile Delta, Lake Mariut, Nozha hydrodome, Lake Manzalah, Aswan High Dam, Sediments, Pollutant identification, Water analysis, Water resources development, Environmental effects, DDT.

After construction was completed on the Aswan High Dam in 1964, both the Nile's flow and sediment load to the Delta region were reduced. Because lake sediments accumulate both natural and anthropogenic components, baseline geochemical information from surficial sediments can serve as a benchmark for evaluating sediment enrichment in the future and can also provide insight into the present environmental quality of the Delta lakes. Chlorinated hydrocarbon concentrations and major and minor trace element status of lake sediments of three Nile Delta lakes were determined: Lake Mariut, Nozha hydrodrome, and Lake Manzalah. Sediment samples were collected from the Delta lakes about 5 yr after the Aswan High Dam gates closed. With a few exceptions, bulk sediment analyses indicate surficial sediments from three delta lakes were not highly enriched in polychlorinated biphenyls, or trace elements. Some exceptions were Cu in Lake Manzalah, and possibly Zn in Lake Mariut. Lake Manzalah had t-DDT concentrations that were higher than other water bodies. It appeared that the majority of the variability of the sediment geochemistry is accounted for by land-derived clays, authigenically derived CaCO3, and Fe chemistry which influenced trace metal distributions. (Baker-IVI)
W85-05037

CHANGES IN THE QUALITY OF NILE WATER IN EGYPT DURING THE TWENTY-FIVE YEARS, 1954-1979,
National Research Centre, Cairo (Egypt).
J. B. Khalil, and F. S. Hanna.
Irrigation Science, Vol. 5, No. 1, p 1-13, April, 1984. 1 Fig, 4 Tab, 15 Ref.

Descriptors: *Nile River, *Egypt, *Water quality, *Aswan Dam, *Giza, Salts, Agricultural runoff, Sulfates, Chlorides, Potassium, Sodium, Magnesium, Hydrogen ion concentration, Carbonates, Calcium.

The study describes the variation in the chemical constituents of the Nile water at Giza, through the twenty-five years from 1954 to 1979 i.e., before and after the construction of the High Dam at Aswan. The total soluble salt content increased significantly by 29% after the construction of the High Dam, mainly due to the seepage of drainage water from the cultivated land of the Nile Valley. The SO4(-), Cl(-), K(+), Na(+) and Mg(2+) content increased significantly during the period of study, while the increase in pH values, HCO3(-) and Ca(2+) contents was significant. The suspend-

ed matter content decreased significantly by 94% from 1964 to 1979 due to the effect of the High Dam. The increase in silica content was significant while the decrease in oxygen content was not significant. No obvious variations were detected in chloride content, total alkalinity and total hardness during the study period. According to the ionic coefficients ratios and the geochemical classification, Nile water currently can be evaluated for irrigation purposes as falling within the class excellent-good and highly satisfactory for domestic purposes. (Author's abstract)
W85-05162

EFFECT OF FURROW IRRIGATION EROSION ON CROP PRODUCTIVITY,
Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center.
D. L. Carter, R. D. Berg, and B. J. Sanders.
Soil Science Society of America Journal, Vol. 49, No. 1, p 207-211, January-February, 1985. 2 Fig, 5 Tab, 4 Ref.

Descriptors: *Soil erosion, *Irrigation effects, *Crop yield, *Furrow irrigation, Tillage, Sedimentation, Erosion, Topsoil, Hardpan.

The effects of furrow irrigation erosion on crop yield have been quantified. Topsoil depth and crop yields were measured on 10 fields. Severe erosion on the upper ends of fields combined with tillage has mixed light-colored subsoil with topsoil and caused these areas to become whitish in color. The average portion of whitish soil was 30% on the 14 farmer operated fields studied. This percentage reflects the degree of erosion over the long term. The length of the whitish soil area does not seem related to the field length. Seventy percent of the furrow irrigated fields in the study area now have whitish soil areas. Those that do not, have slopes less than about 0.7%. Significant yield reductions were noted for all crops on all whitish soil areas studied. Significant yield loses resulting from furrow irrigation erosion are occurring on 21% of the farmed area after 78 years of irrigation. Observations, limited measurements based on reference points, and soil depth measurements downslope indicate that a loss of 20-30 cm over 78 yr of irrigation is common, and in some situations losses are greater. The depth to the hardpan indicates that significant amounts of sediment have been deposited on the middle and lower thirds of fields where the third and fourth transects were made. Topsoil depth clearly had a major impact on crop yields in the study area. The original 38 cm of topsoil was not sufficient for maximum yields in the area. This yield loss cannot be overcome by any method presently known, except possibly the returning of topsoil to eroded areas. (Baker-IVI)
W85-05192

MAMMAL SURVEILLANCE SYSTEM,
Bureau of Reclamation, Denver, CO. Power and Instrumentation Branch.
E. Campbell, and R. Bruce.
Available from the National Technical Information Service, Springfield, VA 22161. Report REC-ERC-82-16. March 1983. 40 p, 29 Fig, 2 Append.

Descriptors: *Infrared photography, *Concrete-lined canals, *Animal behavior, *Escape structures, Infrared imagery, Canals, Electronic equipment, Photography, Sensors, Remote sensing, Mammals, Deer, Surveillance systems.

In response to a need that has developed to monitor animal behavior in using escape structures in concrete-lined canals, a versatile motion sensing device has been devised. The device uses an advanced infrared detector, novel amplifier systems, and extensive logic to trigger three cameras and strobes as needed to photograph deer in four stages of departure from the canal.
W85-05311

ECOLOGICAL COMPARISON OF 6 BOG SITES IN ANNE ARUNDEL COUNTY, MARYLAND,
Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies.
D. Whigham.
Draft Final Report, August 1981, 141 p, 82 Fig, 21 Tab, 9 Ref, Append. Contract/Grant No. C20-81-430.

Descriptors: *Wetlands, *Bogs, *Vegetations, *Substrates, *Plant tissues, *Water quality, *Watershed management, Floristics, Environmental impact statement, Ecological effects, Environmental effects, *Maryland.

An ecological study of 6 wetlands was conducted in Anne Arundel County, at the request of State and County officials to assure that no major impacts would result from development. Primary emphasis of the study was an analysis of vegetation, substrate, plant tissue, and water quality data to determine relationships between and among bogs and adjacent wetland control forests. There appeared to be no unique topographic or geomorphic feature differentiating these bogs, except that all but one developed in areas that previously supported bottomland hardwood foresets. The remaining site, Round Bay Bog developed with the right-of-way corridor of a transmission line. However, clear patterns existed with Cypress Creek and Round Bay Bogs being the most distinct, in terms of floristics, substrate parameters, and plant tissue nutrient concentrations. The other sites (North Grey's, South Grey's, Angel's and Eagle Hill) were rather similar. The purposes of this study were 1) to determine what features could be used to characterize these bogs in comparison to nearby topographically similar yet floristically dissimilar wetlands, and 2) to delineate, if possible, biological and/or chemical parameters that could be used to monitor potential changes that might occur as a result of watershed development. Recommendations are given for each site.
W85-05334

TIDAL POWER: REPERCUSSIONS ON THE AQUATIC ENVIRONMENT (ENERGIE MAREMOTRICE: ASPECTS LIES A L'ENVIRONNEMENT AQUATIQUE),
Museum National d'Histoire Naturelle, Paris (France).
C. Retiere.
Houille Blanche, No. 8, p 583-589, August, 1984. 6 Ref.

Descriptors: *Tidal powerplants, *Environmental effects, *Estuarine environment, *Rance, *France, Ecosystems, Dam effects, Salinity, Water level fluctuations.

A tidal power plant cannot be envisaged without taking into account the impact of such a construction on the marine environment. The Rance basin project has made it possible to demonstrate the way in the estuary's ecosystem had adapted to the new environmental conditions imposed by operation of the plant (water level fluctuations, salinity, etc). The new state of equilibrium takes about ten years to establish itself. It depends on stability of operation in the plant. The dam itself does not hinder the development of profuse and varied forms of life in the estuary. The lessons learned here have been used to assess the possible impact of a tidal power plant such as that of the Cotentin-Centre project, for example. (Author's abstract)
W85-05545

LIMNOLOGY OF SUVIANA-BRASIMONE MAN-MADE LAKES: INFLUENCE OF PUMPED STORAGE OPERATIONS ON PHYSICAL, CHEMICAL AND BIOLOGICAL CHARACTERISTICS,
Bologna Univ. (Italy). Ist. di Zoologia.
G. Salmoiraghi.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1550-1557. December, 1984. 3 Fig, 2 Tab, 19 Ref.

Descriptors: *Lakes, *Limnology, *Pumped storage, *Lake Suviana, *Lake Brasimone, *Italy, Reservoirs, Hydroelectric plants, Phytoplankton, Nitrogen, Phosphorus, Temperature effects, Turbidity, Thermal stratification, Environmental effects.

Lake Suviana lies in the Tusco-Emilian Appenines, at 470 m above sea level, has a maximum capacity of 46,500,000 cu m and is 70 m deep. Lake Brasimone is higher up with a volume of 6,600,000 cu m and a depth of 29 m. A hydraulic connection between the two reservoirs was created in 1975 by means of a double penstock, a hydroelectric generating and pumping plant which exploits the difference in their altitudes. Thermoclines have never been noted for either lake, but for Suviana only, it has been possible to perceive a clear thermal gradient in late summer at depths below the outlet. Thermal curves in Lake Brasimone show temperature equality throughout the year, caused by the generating and pumping system which each day brings about an average exchange of over 25% of the water, thus causing its complete homogenization. In late summer and at the beginning of autumn a sharp reduction in dissolved oxygen in noted in Lake Suviana below the outlet depth, due to degradation and mineralization processes of the organic substance. In Brasimone, even in summer, there is an almost orthograde distribution of dissolved oxygen with concentrations close to 100% saturation. The highest concentrations of inorganic nitrogen were found in winter and decreased gradually as the number of phytoplankton increased in each lake. The reducing environment formed in Lake Suviana in summer below the outlet causes the inorganic P compounds to become soluble again and the highest concentrations were recorded on these occasions, though lower than 0.1 mg/l. The mean P concentrations in Brasimone are always lower than those in Suviana. The phytoplankton population present in the euphotic zone of both lakes is structurally simple. The seasonal succession of chlorophyll a present in the euphotic layer of Suviana reservoir traces the temporal course of the densities and biomasses. The studies seem to point clearly to the amount of influence attributable to the activity of the generating and pumping plant on the limnology of the reservoirs and the importance of following and controlling the impact of these installations on lake ecosystems. (Baker-IVI)
W85-05641

INFLUENCE OF RECENTLY DROWNED TERRESTRIAL VEGETATION ON THE QUALITY OF WATER STORED IN IMPOUNDING RESERVOIRS,
Societe Degremont, Rueil-Malmaison (France).
For primary bibliographic entry see Field 5G.
W85-05646

SHORT TERM RESPONSE OF A NORTHERN LOTIC ECOSYSTEM TO A GREAT REDUCTION IN FLOW (REPONSE, A COURT TERME, D'UN ECOSYSTEME LOTIQUE NORDIQUE A UNE FORTE REDUCTION DE DEBIT),
Laval Univ., Quebec. Dept. de Biologie.
G. Moreau, and D. Planas.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1776-1785, December, 1984. 4 Fig, 5 Tab, 18 Ref.

Descriptors: *Flow, *Diversion, *Ecological effects, *Petite Opinaca River, *Quebec, Phytoplankton, Zooplankton, Turbidity, Light penetration, Primary productivity, Sedimentation, Fish.

The utilization of streams for electric energy generation produces a number of modifications in the aquatic environment, including the creation of reservoirs, modification of hydrologic regimes by barrages, and diversion of rivers. The Opinaca River and its tributary, the Petite Opinaca River, are in the James Bay area, Quebec. The average annual flow under natural conditions was 31 cu m/s for the Petite Opinaca and 202 cu m/s for the Opinaca River. Diversions reduced the flow to 5 and 15 cu m/s, respectively (flow reductions of 84 and 92%). The reductions in flow were accompanied by a reduction in velocity. The physico-chemical properties of the water, primary productivity, zooplankton, benthos and fish were studied in the Petite Opinaca before and after the reduction in flow. The reduction in flow in the upstream section resulted in an increase in the residence time and a great reduction in turbulence, which favor sedimentation of suspended particulates and the

development of planktonic organisms. The increase in light penetration brought about an increase in the phytoplankton primary production, which resulted in an increase in the numbers and biomass of zooplankton, and in particular the cladocerans and copepods. The increase in zooplankton favored the planktonivore fish species and the juvenile stages of a number of other fish species. Modification of habitats was favorable for some species and unfavorable for others. In the downstream section, because of the absence of pools and the presence of a good channel, turbulence was not reduced. Microfiltering organisms were favored by the conditions. (Moore-IVI)
W85-05658

IMPORTANCE OF STREAMSIDE FORESTS TO LARGE RIVERS: THE ISOLATION OF THE WILLAMETTE RIVER, OREGON, U.S.A., FROM ITS FLOODPLAIN BY SNAGGING AND STREAMSIDE FOREST REMOVAL,
Pacific Northwest Forest and Range Experiment Station, Corvallis, OR. Forestry Sciences Lab.
J. R. Sedell, and J. L. Froggatt.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1828-1834, December, 1984. 2 Fig, 1 Tab, 19 Ref. NSF grant DEB-8112455.

Descriptors: *Willamette River, *Oregon, *Flood plains, *Snags, *Riparian vegetation, Forest watersheds, Land use, Channels, Dams, Rivers, Riparian water loss, Channel morphology.

The pristine and present streamside forest, channel geomorphology, and role of downed trees are described in the Willamette River, Oregon. From this case history a modification of the river continuum concept is presented. The Willamette Valley is one of the older settled regions of the American West. The pre-settlement stream had banks 1.5 to 2.6 m above the low water line with a floodplain 1.6 to 3.2 km wide. A dense woodland covered most of the floodplain. By 1872 the channels and sloughs of the Upper Willamette were being closed off and the water confined to one channel. These channels were closed off using nearby snags from the channel and cottonwoods growing along the river. Wing dams were constructed with firs and willows and other smaller trees cut from the banks. From 1879 to 1950 over 65,000 snags and streamside trees were pulled and cut up, an average of 550 snags per kilometer. The 25 km between Harrisburg and the McKenzie River confluence had over 250 km of shoreline in 1854, reduced to 64 km in 1967. This represents a four fold decrease in surface water volume in this section of the Willamette River, as well as a four fold reduction in organic inputs; both leaf litter and wood. The loss of shoreline, fewer and smaller snags and reduced width of the riparian forest was an incredible loss to the Willamette River. Channel structural features, particulate organic inputs from litter fall, and retention capacity for filtering particulates from flood flows and entraining partially decomposed allochthonous organic materials were greatly reduced. Eleven major dams have been built since 1946, after the river was essentially confined to a single channel. The agricultural and navigational demands resulted in the major channel changes and loss of downed-tree inputs before the hydrologic regime was regulated. (Baker-IVI)
W85-05663

STREAM REGULATION OF THE UPPER COLORADO RIVER: CHANNEL CONFIGURATION AND THERMAL HETEROGENEITY,
Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
J. V. Ward.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 1862-1866, December, 1984. 3 Fig, 11 Ref.

Descriptors: *Stream regulation, *Environmental effects, *Species diversity, *Colorado River, *Lake Granby, Dam effects, Channels, Regulation, Temperature effects, Rivers, Population dynamics, Diversion, Rhithron, Trout, Invertebrates, Streamflow, Refugia.

Some effects of a transmountain diversion scheme on a regulated rhithron segment of the Colorado River near its origin in the Rocky Mountains were examined. Special attention was given to the macroinvertebrate community which tends to integrate the unique combination of physical and chemical variables at a given site, Lake Granby, a deep release storage reservoir, which was constructed in the 1940's. Although temperature and certain other factors are clearly altered by stream regulation, environmental conditions are generally suitable for lotic organisms and there is a productive trout fishery in the stream reach below the dam. Woody riparian vegetation consists of willows and alder. Rubble is the dominant substrate. Dissolved oxygen levels are at or near saturation with values ranging from 8.4 to 11.8 mg/l. The macroinvertebrate community of the Colorado River below Granby Dam was characterized by high density and biomass values, altered community structure, and reduced Shannon diversity compared with unregulated mountain streams. Unregulated rhithron sites exhibited a more even distribution of major zoobenthic groups than the Colorado River where ephemeropterans and dipterans collectively comprised 97% of the numbers and 82% of the biomass. Species diversity was depressed in the Colorado River compared to the range of values exhibited by the unregulated rhithron locations. It is postulated that the altered flow regime below Granby Dam has resulted in a channel configuration that fortuitously provides thermal refugia for species that would not otherwise be present. The putative relationship between channel configuration and thermal heterogeneity may account for otherwise inexplicable differences in community sructure between seemingly comparable regulated streams. The availability of temperature microhabitats should be considered when designing ecological studies of regulated streams and when interpreting the results of such investigations. (Baker-IVI)
W85-05666

SESTON TRANSPORT IN STREAMS AT COWEETA HYDROLOGIC LABORATORY, NORTH CAROLINA, U.S.A.,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 2J.
W85-05671

MANAGEMENT OF DITCHES. THE EFFECT OF CLEANING OF DITCHES ON THE WATER COENOSES,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Landscape Ecology and Nature Management.
B. Beltman.
Verhandlung Internationale Vereinigung Limnologie, Vol. 22, No. 3, p 2022-2028, December, 1984. 4 Fig, 2 Tab, 9 Ref.

Descriptors: *Ditches, *Aquatic weed control, *Environmental effects, *Netherlands, Drainage, Agriculture, Drainage ditches, Aquatic life.

The ditches in the Dutch landscape, dug to improve drainage and make land suitable for agriculture, are shallow and seldom shaded. Due to the luxuriant growth of water plants, ditches can become covered over and blocked with vegetation, which hinders their drainage function. To prevent this the farmers and local water boards clean their ditches in autumn by removing most of of the plants and a part of the sapropelium from the ditches and putting it onto the banks. The cleaning is often done using manual equipment, but mechanized methods are becoming more common. The ditch-scoop and the mowing basket are most frequently used. The method of cleaning the ditches and the period in which ditches are cleaned influence the composition of macrofauna and of water, bank zone and bank plants. The mowing basket favors the growth of floating water plants, while the ditch scoop favors the submerged water plants and the filamentous algae. Also at the level of the plant species themselves the methods of cleaning have a remarkable effect. The different cleaning methods have an effect on the number of species and specimens in the macrofauna. Abiotic differences like seepage have their influence on the composition of the macrofauna. Influences from differences in the physical chemical composition of the water could not be demonstrated. (Baker-IVI)
W85-05682

ASSESSMENT OF INTERGRAVEL CONDITIONS INFLUENCING EGG AND ALEVIN SURVIVAL DURING SALMONID REDD DEWATERING,
Battelle Pacific Northwest Labs., Richland, WA. Environmental Sciences Dept.
C. D. Becker, and D. A. Neitzel.
Environmental Biology of Fishes, Vol. 12, No. 1, p 33-46, January 1985. 4 Fig, 64 Ref. DOE contract DE-AC06-76RL0 1830.

Descriptors: *Salmonids, *Fish eggs, *Embryos, *Dewatering, *Mortality, *Water level fluctuations, Reservoir operation, Stream flow, Immature growth stages, Environmental effects.

In the Pacific Northwest, water-use conflicts often involve changes in stream flows that encroach upon the ecological requirements of salmonids. Extensive water use may alter stream flows so that areas used by salmonids for spawning are dewatered, thus exposing intergravel development phases to suddenly changed physical and chemical conditions. Environmental alteration may result in considerable mortality, particularly of the more vulnerable post-hatch phases. Review of five documented case histories of redd dewatering by dam operation or drought indicates that the primary factors that influence the survival of salmonid eggs, embryos and alevins are the following: species characteristics; alevin movement; dissolved oxygen; gravel composition; temperature; moisture retention; and residual flow. In field situations, typically compex ecological relationships prevail, and most ecological conditions will depend on each other in one way or another. Whenever spawning areas are dewatered at a time when intergravel development phases of salmonids are present, on-site studies should be made to quantify physical and chemical phenomena in the gravel, as well as to determine survival rates. (Moore-IVI)
W85-05711

ALTO SINU HYDROELECTRIC PROJECT IN COLOMBIA: POSSIBLE CONSEQUENCES FOR THE ENVIRONMENT,
Rijksinstituut voor Natuurbeheer, Leersum (Netherlands).
For primary bibliographic entry see Field 2H.
W85-05718

WATER QUALITY AND WATERSHED LAND USED OF JOHNSON SAUK TRAIL LAKE,
Illinois State Water Survey Div., Peoria. Water Quality Section.
R. K. Raman, and R. L. Evans.
Transactions of Illinois Academy of Sciences, Vol. 77, No. 3/4, p 155-170, 1984. 8 Fig, 6 Tab.

Descriptors: *Water quality, *Land use, *Johnson Sauk Trail Lake, *Illinois, Watersheds, Phosphorus, Eutrophic lakes, Cycling nutrients, Macrophytes, Pesticides, Heavy metals, Organic compounds.

A study of Johnson Sauk Trail Lake, Henry County, was conducted in 1981 to delineate existing lake conditions, to examine causes of degradation, if any, and to identify and quantify the sources of nutrients and any pollutants flowing into the lake. The lake watershed, in general, is in excellent condition with excellent ground cover and very little land disturbance. The lake water quality characteristics were found to be typical of midwestern lakes, with high alkalinity, conductivity, and dissolved solids. There was an abundance of phosphorus in the lake system all the time. The main lake tributaries were not found to convey unusual amounts of suspended sediment loads. Fish flesh analyses revealed levels of pesticides, heavy metals, and organochemicals either below detectable limits or below regulatory limits. A number of water quality impairments were found to persist in the lake, including hypolimnetic oxygen depletion during summer months, algal blooms, and dense

macrophyte growths in the littoral zone. Internal regeneration of nutrients was identified as the major source of nutrients to the lake. The lake is eutrophic by all the measures and indices suggested in the literature. (Author's abstract)
W85-05722

PREDICTED EFFECTS OF INCREASING SALINITY ON THE CRUSTACEAN ZOOPLANKTON COMMUNITY OF PYRAMID LAKE, NEVADA,
Colorado Cooperative Fishery Research Unit, Fort Collins.
D. L. Galat, and R. Robinson.
Hydrobiologia, Vol. 105, p 115-131, November, 1983. 9 Fig, 4 Tab, 48 Ref. Bureau of Indian Affairs contracts 14-16-0008-974 and K51C14201130.

Descriptors: *Salinity, *Crustaceans, *Zooplankton, *Pyramid Lake, *Nevada, Walker Lake, Water diversion, Bioassay, Species diversity, Saline lakes, Ecological effects.

Because of major upstream transbasin water diversions, the salinity of Pyramid Lake, Nevada has increased 32% from about 3.75 0/00 in 1933 to nearly 5.50 0/00 in 1980. It has been hypothesized that further increases of 1.5 to 2 times (1.5X to 2X) its present salinity would significantly reduce species richness and alter population structures of the existing crustacean zooplankton community. The present zooplankton community of Walker Lake (2X) was compared with that existing in Pyramid Lake (1X). Ceriodaphnia quadrangula and Diaphanosoma leuchtenbergianum, both collected from Pyramid Lake, were lacking in Walker Lake. Populations of Cyclops vernalis were significantly lower and those of Diaptomus sicilis and Moina hutchinsoni were significantly higher in Walker Lake than in Pyramid Lake. Densities of Ceriodaphnia and Cyclops were low in microcosms at salinities > 1X. Diaphansoma could not be maintained in microcosms, regardless of salinity. Numbers of Diaptomus and Moina in microcosms were proportional to salinity level. Short-term LC50 salinities (0/00) were as follows: Diaphanosoma, 6.5; Ceriodaphnia, 7.1; Diaptomus, 13.3; Cyclops, 14.8; and Moina, 17.8. Multiple-generation, chronic bioassays were run only on Cyclops and Diaptomus. Three generations of Cyclops were produced at salinities of 4.0 to 8.5 0/00, but not at 9.8 0/00 or higher. Diaptomus was unable to complete three generations at salinities > or = 9.6 0/00. If the salinity of Pyramid Lake increases 1.5 to 2X, crustacean zooplankton diversity will probably decline as the community shifts towards dominance by a few species resistant to high salinity. (Moore-IVI)
W85-05754

VAST DIVERSION OF SOVIET RIVER,
P. P. Micklin.
Environment, Vol. 27, No.2, p 12-20, 40-45, March, 1985. 4 Fig, 1 Tab, 78 Ref.

Descriptors: *Water resources development, *Diversions, *Siberia, *USSR, *Environmental effects, Water transfer, Water management.

The Soviet Union is on the verge of constructing a water management scheme that is unprecedented in its scale. It is planning to transfer large quantities of river water now flowing into northern drainage basins and divert them into southern drainage basins. The goal is to complete the undertaking by 1990, when diversion of 5.8 cu km of water per year is to begin. The rationale for the water transfers is reviewed. The characteristics of Soviet river diversion projects are tabulated. Specific attention is given to the European diversions, the Siberian transfers, and the impacts these diversions will have on the environment, including concern over possible effects on the Arctic ice cover. (Baker-IVI)
W85-05767

7. RESOURCES DATA

7A. Network Design

PROPOSAL TO CONSTRUCT A COORDINATING MATRIX FOR COMPARATIVE HYDROLOGY,
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
G. Kovacs.
Hydrological Sciences Journal, Vol. 29, No. 4, 435-443, December, 1984. 3 Fig.

Descriptors: *Hydrologic models, Model studies, Hydrological regime, Morphology, Climatic data, Hydrologic balance.

When the development of hydrological sciences became linked to a large international program, the limitations to the application of conventional methods in areas with different characteristics were immediately recognized. The establishment of a multi-dimensional matrix which summarizes the various factors reflecting the different ratios of the water balance components and indicating the special processes to be considered when the hydrology of a given region is being investigated is seen to be a requirement. Attention is given to factors which modify the hydrological regime, the effect of morphology on hydrological processes, the influence of climatic conditions on hydrology, and the proposed form of the coordinating matrix. (Baker-IVI)
W85-05007

MULTICRITERION NETWORK DESIGN USING GEOSTATISTICS,
Arizona Univ., Tucson. Dept. of Systems and Industrial Engineering.
For primary bibliographic entry see Field 2F.
W85-05499

NOTE ON SELECTING AN OPTIMUM RAIN-GAUGE SUBSET,
Waikato Univ., Hamilton (New Zealand). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2B.
W85-05541

7B. Data Acquisition

PORTABLE MONITOR FOR MEASUREMENT OF DISSOLVED SULFIDE BASED ON THE GLASS/SULFIDE-SELECTIVE ELECTRODE COUPLE,
Atomic Energy of Canada Ltd., Chalk River (Ontario).
J. Gulens.
Water Research, Vol. 19, No. 2, p 201-204, 1985. 3 Fig, 1 Tab, 23 Ref.

Descriptors: *Monitoring, *Water analysis, *Glass/sulfide electrode, *Sulfides, Electrodes, Groundwater monitoring, Water quality control, Dissolved solids.

A portable monitor has been used to measure dissolved sulfide in uncontaminated and contaminated ground waters, and there is good agreement between the monitor response and the results of analyses of grab samples. The response of the monitor is based on the potential of a glass-sulfide selective electrode couple measured in acidic solutions. This approach appears to have overcome many of the problems associated with the conventional potentiometric determination of sulfide. A particular advantage of the monitor is that it uses the actual sample for calibration in the field. Thus, shifts in the calibration curve arising from changes in the composition of the ground water can be detected and accounted for. Also, the ability to check the accuracy of the monitor during measurement of a sample by the method of standard addition allows one to verify that such shifts are real and due to some chemical interaction between the solution and electrode surface and not due to some instrument instability or failure. Advantages of the glass/sulfide electrode pair are also discussed. (Baker-IVI)
W85-04975

SIMPLE CULTIVATION UNIT FOR THE EVALUATION OF ALGAL GROWTH POTENTIAL AND TOXICITY OF WATER,
Ceskoslovenska Akademie Ved, Trebon. Dept. of Hydrobotany.
J. Lukavsky.
Water Research, Vol. 19, No. 2, p 269-270, 1985. 1 Fig, 3 Ref.

Descriptors: *Bioassays, *Algal growth potential, *Toxicity, Algae, Growth, Laboratory equipment, Water pollution effects.

A cultivation unit was designed for testing algal growth potential (AGP) and toxicity of waters and of soil extracts (for evaluation of soil fertility); the system may also be used for testing and screening of biologically active substances, heavy metals, pesticides, and biostimulatory compounds. The cultivation unit is illuminated by an incandescent lamp which is heat-filtered by a container with 6 cm of water. The cultivation area is a covered and sealed plastic box to which CO2 is supplied through a hole; concentration of CO2 is monitored with an indicator in a small polyethylene bag hanging inside the cultivation area. Gauze saturated with water maintains a high humidity level in the box. Microtitration plates or Petri dishes containing solid media are placed in the cultivation area with their lids upward. The alga Chlorella kessleri may be used for bioassays. Consumption of CO2 by photosynthesis of the colonies is very small. An addition of CO2 every second day is sufficient providing that the sealing of the box is good. (Collier-IVI)
W85-04983

SATELLITE PASSIVE MICROWAVE RAIN RATE MEASUREMENT OVER CROPLANDS DURING SPRING, SUMMER AND FALL,
Wisconsin Univ.-Madison. Space Science and Engineering Center.
For primary bibliographic entry see Field 2B.
W85-04984

USE OF AERIAL PHOTOGRAMMETRY FOR TRADITIONAL SURVEYS OF FLUCTUATIONS IN GLACIAL SPITS (UTILISATION DE LA PHOTOGRAMMETRIE AERIENNE POUR LES RELEVES TRADITIONNELS DE FLUCTUATIONS DES LANGUES GLACIARES),
Centre National de Machinisme Agricole du Genie Rural, des Eaux et des Forets, Saint-Martin-d'Heres (France). Div. Glaciologie.
For primary bibliographic entry see Field 2C.
W85-05020

AUTOMATIC MONITORING OF WATER QUALITY,
T. Kohonen.
Vesientutkimuslaitoksen Julkaisuja, No. 49, p 40-53, 1982. 7 Fig, 4 Tab, 23 Ref.

Descriptors: *Automation, *Water quality, *Monitoring, *Finland, Computers, Conductivity, Hydrogen ion concentration, Dissolved oxygen, Turbidity, Chlorides, Thermal pollution, Water pollution.

Since the early nineteen seventies, the Finnish National Board of Waters has been actively engaged in the development of automatic water quality monitoring with the purpose of detecting immediately the discharge of pollutants into waterways. Eleven automatic water quality monitoring stations have been used, of which five are part of a computer controlled system in the rivers Kymijoki and Kokemaenjoki and the others are mobile stations. The parameters measured are temperature, pH, conductivity, dissolved oxygen and turbidity, and at five stations also chloride. The major causes of disturbances were associated with water intake and malfunction of microprocessors and the central computer. Effective operation times varied be-

tween 30 and 100% of the total measuring time. Automatic monitoring has in several cases revealed previously undetected variations in water quality. Of the 5-6 measurement parameters used, at least one always reacted to changes in water quality. The primary data obtained has been utilized with the aid of statistical methods in an attempt to determine the necessary sampling frequency for a given confidence of calculated means. (Collier-IVI)
W85-05063

USE OF SIMPLE KINETIC MODELS TO HELP DESIGN ENVIRONMENTAL MONITORING SYSTEMS,
EG and G Idaho, Inc., Idaho Falls.
For primary bibliographic entry see Field 5A.
W85-05102

QUICK METHOD OF FIELD OBSERVATIONS OF WASTEWATER SPREADING IN LAKES,
For primary bibliographic entry see Field 5A.
W85-05161

MEASUREMENT OF SOIL WATER CONTENT USING TIME-DOMAIN REFLECTROMETRY (TDR): A FIELD EVALUATION,
Department of Agriculture, Ottawa (Ontario). Land Resource Research Inst.
For primary bibliographic entry see Field 2G.
W85-05180

ELECTRONIC DISCRIMINATOR TO ELIMINATE THE PROBLEM OF HORIZONTAL RAINDROP DRIFT,
Missouri Univ.-Columbia. Dept. of Agronomy.
C. J. Gantzer, E. E. Alberts, and W. H. Bennett.
Soil Science Society of American Journal, Vol. 49, No. 1, p 211-215, January-February, 1985. 2 Fig, 1 Tab, 6 Ref.

Descriptors: *Rain, *Photoelectric detectors, *Discriminators, Measuring instruments, Erosion, Rainfall simulator, Soil splash.

A simple electronic apparatus is described which has been designed to eliminate the problem of horizontal waterdrop drift during freefall. Such drift causes difficulty in collecting uniform soil splash samples from single-drop detachment studies. The electronic discriminator can be used easily with any single drop rainfall tower. The main detector of the discriminator consists of two optical light source-sensors positioned at right angles in a horizontal plane. These sensors detect and select for use only those drops falling within a 6.4 mm square target window. The discriminator can be built for about $400, including labor and materials. In one experiment to test the performance of the discriminator drop masses were analyzed which had been collected both with and without use of the discriminator and compared with drops collected directly from the drop former. No significant difference in mass between drops collected with the device and those collected directly from the drop former was found. A significant decrease in drop mass was found without use of the device. The discriminator also decreased drop mass variance about six times. In a second experiment soil splash was measured from uniformly packed cores of Norbourne fine sandy loam. An average splash increase of about 46% was noted when using the device vs not using it, insuring against biasing of raindrop kinetic energy vs soil splash relationships. (Baker-IVI)
W85-05193

GUIDE TO THE SELECTION OF MATERIALS FOR MONITORING WELL WELL CONSTRUCTION AND GROUND-WATER SAMPLING,
Illinois State Water Survey Div., Champaign.
M. J. Barcelona, J. P. Gibb, and R. A. Miller.
Available from the National Technical Information Service, Springfield, VA 22161, as PB84-141779. Report EPA-600/2-84-024, January 1984, 87 p. 5 Fig, 18 Tab, 160 Ref. Contract/Grant No. CR-809966.

Descriptors: *Hydrology, *Groundwater, *Aquifers, *Wells, Legislation, *Cost-benefit analysis, Sampling, Pollutant identification, *Monitoring, Groundwater management, Pumps.

Existing guidance documents for effective groundwater monitoring efforts were updated. The areas of primary concern were the potential sources of errors in chemical analyses of subsurface samples caused by well construction and sampling materials, techniques or procedures. A critical review of the literature was conducted on various aspects of monitorng natural waters, materials' performance data and unpublished information on the success of various ground-water monitoring techniques. The costs and benefits of recommended monitoring design criteria are given in detail.
W85-05350

REMOTE SEMIAUTOMATIC INSTRUMENTATION FOR INTERMITTENT STREAMFLOW MEASUREMENT AND SUSPENDED SEDIMENT SAMPLING,
Alberta Univ., Edmonton. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W85-05461

USE OF SATELLITE DATA FOR MONITORING OIL SPILLS IN CANADA,
INTERA Environmental Consultants Ltd., Ottawa (Ontario).
T. T. Alfoldi, and N. A. Prout.
EPS 3-EC-82-5, December 1982. 64 p, 19 Fig, 11 Tab, 3 Append, 31 Ref.

Descriptors: *Satellite technology, *Oil slicks, *Oil spills, *Remote sensing, *Infrared imagery, *Monitoring, *Data acquisition, *Monitoring, *Data collections, Spectral analysis, Telemetry, Radiometry, Oil pollution.

Satellite remote sensing of marine oil spills using the visible and infrared bands is reviewed. The Landsat satellite series features return beam vidicon cameras, and multispectral scanners. The NOAA satellite series was launched primarily to gather meteorological data for the U.S. and Canada. The AVHRR sensor aboard the TIROS-N/NOAA satellites is of primary interest to oil spill studies due to its 1 km resolution ability. On the GOES satellites, the Visible and Infrared Spin Scan Radiometer (VISSR) imagery is of interest in the monitoring of ocean oil spills. Future satellite systems will include Landsat D and D' which will feature a thematic mapper and multispectral scanner, the French remote sensing satellite SPOT featuring a matched pair of sensors, and the NOAA satellites. The technical considerations involving the ability of satellites to detect marine oil slicks falls into four basic categories: temporal, spatial, spectral, and radiometric. Methods for the acquisition and use of these satellite data in a spill emergency are detailed. Past experience in identifying oil spills has led to the conclusion that satellite systems are not configured to provide operational oil spill monitoring.
W85-05578

NOTE ON TURBULENT PERTURBATIONS OF SALINITY IN A PARTIALLY MIXED ESTUARY,
Birmingham Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W85-05689

COMPARISON OF DAILY AND WEEKLY PRECIPITATION SAMPLING EFFICIENCES USING AUTOMATIC COLLECTORS,
Geological Survey, Lakewood, CO.
L. J. Schroder, R. A. Linthurst, J. E. Ellson, and S. F. Vozzo.
Water, Air, and Soil Pollution, Vol. 24, No. 2, p 177-187, February, 1985. 5 Fig, 4 Tab, 14 Ref.

Descriptors: *Precipitation, *Sampling, *Automation, Rain gages, Evaporation, Hydrogen ion concentration, Specific conductance, Samplers, Raleigh, North Carolina.

Precipitation samples were collected for approximately 90 daily and 50 weekly sampling periods at Finley Farm, near Raleigh, North Carolina from August 1981 through October 1982. Ten wet-deposition samplers (Aerochem Metrics Model 301) were used; 4 samples were operated for daily sampling and 6 samplers were operated for weekly-sampling periods. This design was used to determine if: (1) collection efficiencies of precipitation are affected by small distances between the Universal (Belfort) precipitation gage and collector; (2) measurable evaporation loss occurs and (3) pH and specific conductance of precipitation vary significantly within small distances. Average collection efficiencies were 97% for weekly sampling periods compared with the rain gage. Collection efficiencies were examined by seasons and precipitation volume. Neither factor significantly affected collection efficiency. No evaporation loss was found by comparing daily sampling to weekly sampling at the collection site, which was classified as a subtropical climate. Correlation coefficients for pH and specific conductance of daily samples and weekly samples ranged from 0.83 to 0.99. (Author's abstract)
W85-05694

VARIATION IN PH DURING SUMMER STORMS NEAR THE CONTINENTAL DIVIDE IN CENTRAL COLORADO, U.S.A.,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 2K.
W85-05766

WET DEPOSITION MONITORING - EFFECT OF SAMPLING PERIOD,
Pennsylvania State Univ., University Park. Dept. of Meteorology.
For primary bibliographic entry see Field 5A.
W85-05773

GRAN'S TITRATIONS: INHERENT ERRORS IN MEASURING THE ACIDITY OF PRECIPITATION,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5A.
W85-05774

COLLECTION OF FOG DRIP,
San Jose State Univ., CA. Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W85-05802

7C. Evaluation, Processing and Publication

WGEN: A MODEL FOR GENERATING DAILY WEATHER VARIABLES,
Agricultural Research Service, Washington, DC.
C. W. Richardson, and D. A. Wright.
Report ARS-8, August 1984. 83 p, 3 Fig, 12 Tab, 13 Ref, 4 App.

Descriptors: *Weather forecasting, *Simulation, *Computer models, *Markov process, *WGEN, *Weather Generator, Temperature, Solar radiation, Synthetic weather data.

Daily weather data are required for many applications. Weather data are frequently needed to aid in the design of hydraulic structures; to evaluate the effects of watershed changes on hydrology, water quality or erosion; or to assess alternative crop or range management strategies. Mathematical models of the physical processes involved are often used to make these evaluations. Further, it is desirable to have the capability of generating synthetic weather data with the same statistical characteristics as the actual weather at the location. This paper presents a computer simulation model called WGEN (Weather Generator) that provides daily values for precipitation, maximum temperature, minimum temperature, and solar radiation. The model accounts for the persistence of each vari-

able, the dependence among the variables, and the seasonal characteristics of each variable. Its parameters are defined for locations in the United States, enabling use of the model in the 48 contiguous States without reference to actual data. Examples of model applications are given, and weather data generated by the model are compared with actual data.
W85-05129

8. ENGINEERING WORKS

8A. Structures

PROSPECTS OF USING AUTOMATED MANAGEMENT SYSTEMS IN EARTH-DAM CONSTRUCTION,
N. G. Savchenkov, S. Ya. Laschchenov, V. V. Vil'vovskii, and R. G. Erchikovskii.
Hydrotechnical Construction, Vol. 178, No. 5, p 195-199, May, 1984. 1 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, May 1984.

Descriptors: *USSR, *Dam construction, *Earth dams, *Automated management systems, Computers, Construction, Planning, Decision making.

The need for modern computers to manage dam construction activities in the Soviet Union is discussed. The functions, structure, and stages of introducing such an automated system are noted. The system consists of a specialized wired-program computer and dump-truck identification, weighing, and display apparatus. Structurally the system consists of a central control point housing the computer, printers, radio equipment, loudspeaker and selective calling systems, TV, and three identification-weighing points consisting of scales, secondary weighing apparatus, and other devices. The experience of using the automated system at the Nurek hydrostation makes it possible to critically evaluate the presently existing methods of controlling and managing dam construction processes and on the basis of this to give suggestions on the creation of a new, more functionally extensive automated management system. (Baker-IVI)
W85-05022

SELECTION AND SUBSTANTIATION OF EFFECTIVE DRAINAGE PROTECTION OF THE GATE WORKS OF THE DIVERSION TUNNELS OF THE ROGUN HYDROELECTRIC STATION,
R. Kh. Bukhairov, A. I. Yugai, and V. F. Ilyushin.
Hydrotechnical Construction, Vol. 18, No. 5, p 234-240, May, 1984. 3 Fig, 8 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 36-40, May, 1984.

Descriptors: *Drainage, *Dam construction, *Underground structures, Diversion structures, Rogun hydroelectric station, Tunnels, Seepage, Permeability, Gates, Hydroelectric plants.

The underground structures of the Rogun hydroelectric station include the powerhouse complex (PHC), combined shaft and tunnel service spillways, diversion tunnels, grouting tunnels and shafts, transportation tunnels, and other underground workings. The low permeability and high tectonic compressive stresses in the rock mass made it possible to locate the chamber-type underground structures for the upper pool under the reservoir bed. A well drainage curtain located on the upstream side of the grouting zone was used as the main measure on protecting the underground chambers from seepage. In the Rogun hydroelectric station, in the absence of drainage the linings of the gate hoisting chambers of the diversion tunnels will experience a pressure up to 2.50 MPa. With operation of just the main drainage system of the PHC this pressure decreases to 1.80 MPa; with the combined operation of the drainage systems of the PHC and gate works of the diversion tunnels the seepage pressure on the linings of the latter decreases to 0.08-0.32MPa; with the operation of the local borehole drainage of the hoisting chambers, the pressure near the boreholes decreases to 0.01 MPa. With the combined operation, the main drainage systems of the PHC receives 12,300 cu m/day of water and the drainage system of the gate works 7650 cu m/day. Operation of the borehole drainage increases the seepage flow to the chambers by about 300 cu m/day. (Baker-IVI)
W85-05027

HEAVY SNOW LOADS PLAGUE RESERVOIR ROOF,
Culp/Wesner/Culp, Cameron Park, CA.
R. L. Culp, R. G. Baer, G. Plasterer, and P. English.
Public Works, Vol. 115, No. 8, p 80-82, August, 1984. 5 Fig.

Descriptors: *Reservoir covers, *Snow, *Stateline Reservoir, *California, Engineering, Storage reservoirs, Reservoirs.

Stateline Reservoir is a public water supply reservoir with a capacity of about 1.6 MG. In March 1983, a major portion of the reservoir roof collapsed due to the weight of snow on it. Various solutions to the problem were considered including reconstruction, partial reconstruction, new construction, use of a floating cover, air supported cover, geodesic dome, or the building of a new facility. The floating cover was finally accepted and installed by October 1983. The cover fully protects the water stored in the reservoir against airborne contamination and complies with structural and safety needs. During 1983-84, when once again severe snows were experienced, it gave evidence of being an acceptable solution. (Baker-IVI)
W85-05482

STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA,
WRC Engineering, Inc., Denver, CO.
For primary bibliographic entry see Field 4A.
W85-05484

WORK RESUMED ON WATER TUNNEL.
Public Works, Vol. 115, No. 7, p 184-190, September, 1984. 2 Fig.

Descriptors: *Tunnels, *Construction, *New York City, *New York, Water conveyance, Tunnel construction.

A $120 million contract for the final section of Stage 1 of New York City's Third Water Tunnel calls for excavation of a 24 ft tunnel 8,240 ft long through bedrock some 500 to 700 ft below the surface of Manhattan, then concrete lining the mined out portion and lining a previously mined 9,000 ft section. Stage 1 is only the first in a planned four stage tunnel system that will comprise the whole of Water Tunnel No. 3. The need for the four stages are an increase of the delivery capacity and pressure to meet a growing demand in the easterly and southerly areas of the city, which are furthest from the existing tunnels; a need to reduce high flows in the existing tunnels; and a need for inspection and performing any rehabilitation of the existing tunnels. (Baker-IVI)
W85-05485

PROGRAM MANAGEMENT KEEPS ANCHORAGE WATER PROJECT ON SCHEDULE,
Montgomery (James M.), Inc., Pasadena, CA.
For primary bibliographic entry see Field 6A.
W85-05486

TWENTY YEARS AFTER: AN EXPERIMENT IN TIDAL POWER (VINGT ANS APRES LA RANCE, UNE EXPERIENCE MAREMOTRICE),
Groupe Mixte Exploitation Bretagne Electricite de France.
P. Hillairet.
Houille Blanche, No. 8, p 571-582, August 1984. 7 Ref.

Descriptors: *Tidal powerplants, *Rance, *France, Powerplants, Hydraulic machinery, Tidal energy, Civil engineering.

This experiment is still unique of its kind because Rance (France), the only tidal power station in the world in regular operation, can no longer be considered as just a prototype. The materials utilized, the bold design of this hydraulic power plant and harnessing of tidal energy in general have preoccupied pioneers and engineers alike over the years. But what is the situation now, after twenty years. Civil engineering works and electrical and mechanical equipment have stood the test of time and fulfilled the expectations placed in them, because they now provide electric power at a very competitive price on a regular commercial basis. The article outlines the problems encountered over these twenty years of operation. (Author's abstract)
W85-05544

FROM THE ATLANTIC TO THE GREAT LAKES: A HISTORY OF THE U.S. ARMY CORPS OF ENGINEERS AND THE ST. LAWRENCE SEAWAY,
George Washington Univ., Washington, DC.
W. H. Becker.
Office of the Chief of Engineers (Army), Washington, DC. EP 870-1-20, October 1984. 179 p.

Descriptors: *History, *St. Lawrence Seaway, *Navigation canals, *Corps of Engineers, Great Lakes, International waters, Construction costs, Political aspects, Engineering.

The Corps of Engineers played a major part in the planning, design, and construction of the St. Lawrence Seaway, and international power and navigation project. Improvements for navigation required building two American and four Canadian locks, constructing ship channels in the International Rapids and the Lacine (Montreal) sections of the river, and extensive dredging in the St. Lawrence. The power works, a joint effort of New York State and Ontario, called for a powerhouse across the north channel of the St. Lawrence River and the construction of a powerhouse spillway dam, the Long Sault Dam. A control dam crossed the river in the vicinity of Iroquois Point to regulate the outflow of Lake Ontario. These navigation and power improvements required an extensive system of dikes and the relocation of towns, roads, railroads, bridges, and power lines. By the time the Seaway officially opened on 26 June 1959, the United States had spent $131 million, Canada $340 million, and New York and Ontario each $300 million. The scope of the Corps' role in the project was determined in part by its long involvement in the development of the St. Lawrence; in part by events and political relationships and controversies in the United States and Canada; and in part by the engineering issues involved in, and the organizational structure devised for, the successful completion of the project. Based on extensive research in the published and archival sources of the Corps, Congress, and the Bureau of the Budget, this study covers each of these determinants, then provides an assessment of the effectiveness of the Seaway.
W85-05576

HYDRO ENERGY IN CZECHOSLOVAKIA,
Ceske Vysoke Uceni Technicke v Praze. Faculty of Civil Engineering and Architecture.
L. Votruba.
International Water Power and Dam Construction, Vol. 37, No. 3, p 13-16, March, 1985. 3 Fig, 2 Tab, 2 Ref.

Descriptors: *Hydroelectric power, *Czechoslovakia, Pumped storage, Reviews, Energy, Hydroelectric plants.

The hydro energy situation in Czechoslovakia is a typical example of power generation and supply in a highly developed country with rich deposits of fossil fuel, but with hydropower resources that are limited by relatively low flow rates and relatively low heads. Therefore the main role of hydroelectric stations is to cover peak loads rapidly. Pumped-storage plants are of great importance because by balancing the daily and weekly load curves effectively, they create favorable conditions for the operation of thermal and nuclear powerplants. As is the case in some other countries, the operation of most small hydro stations ceased in

past decades. With the development of the system of power generation and supply, rationalized design of sets, and automatic control, small hydro plants have again become a useful supplement for the electrification system. Water schemes and dams built for other main purposes are also being used for hydropower. All this has lead to a great effort being aimed at the exploitation of all sources of hydro energy that are both economical and technically feasible. (Baker-IVI)
W85-05816

ROMANIA GIVES PRIORITY TO EMBANKMENT DAMS,
National Committee on Large Dams, Bucharest (Romania).
V. Focsa, and D. Mihail.
International Water Power and Dam Construction, Vol. 37, No. 3, p 16-19, March, 1985. 8 Fig, 2 Tab.

Descriptors: *Dam construction, *Romania, *Embankments, *Earth dams, *Rockfill dams, Hydroelectric plants, Policy making, Water resources development.

An overview is presented of policies in the energy sector in Romania which are concerned with the development of all available hydroelectric resources and the construction of a number of large dams. The particular focus of the review is on the construction of high embankment dams for hydropower. Between 1953 and 1982, 101 large dams were constructed in Romania. These were built for multipurpose schemes with hydropower as one of the principal functions. Ten are between 60 and 100 m high and five are higher than 100 m. The type of dam in each case was established according to the geological and topographical conditions at the site as well as economic criteria. Of the concrete dams, four are of the gravity type, one of which is 127 m high. There are also 14 arch dams and four buttress dams. Embankment structures, however, represent the majority of Romanian dams. The characteristics of major earth and rockfill dams in Romania are tabulated. These were constructed mainly for reservoirs associated with low-head hydro plants. Stability analysis of the fill dams is based on extensive foundation and soil investigations, as well as laboratory tests, and has required modern design methods such as the slices method, model tests, and the finite element method which is applied to the embankment and its foundation, and used to test for liquefaction under dynamic earthquake stresses. Upstream concrete facings have generally been used for embankments less than 100 m high, and impervious cores for the higher ones. Bituminous concrete facings and thin membranes have also been used. (Baker-IVI)
W85-05817

SRI LANKA'S KOTMALE HYDRO PROJECT,
Halcrow (William) and Partners, Colombo (Sri Lanka).
E. M. Gosschalk, and A. D. Longman.
International Water Power and Dam Construction, Vol. 37, No. 3, p 21-26, March, 1985. 6 Fig, 2 Tab.

Descriptors: *Mahaweli Ganga Development, *Sri Lanka, *Kotmale Hydroproject, *Powerplants, Construction, Hydroelectric plants, Dams, Tunnels, Spillways.

The Kotmale hydropower project is a major component of the massive Mahaweli Ganga development. Adverse geological conditions at the originally planned dam site necessitated a change in the dam's location, and a comprehensive account of the investigations and project design is presented here, together with details of the main features of the scheme. The Kotmale Oya originates in the south central massif at an elevation of about 2100 m. The dam is 87 m high above river bed level, and has a crest length of 600 m. The intake to the low pressure tunnel carrying water to the power station is on the right bank immediately upstream of the dam with its sill at elevation 654 m. The first part of the tunnel system carrying the flow from the reservoir to the power station is a 6.4 m equivalent diameter concrete lined horseshoe-shaped low pressure tunnel. Upstream and downstream surge chambers are provided to reduce the transient pressures tranmitted into the headrace and tailrace tunnels, and to limit the water acceleration time. The power station which houses the generating plant is an underground cavern 67 m long by 20 m wide by 38 m high. The outfall from the tailrace tunnel will be on a flood channel of the Mahaweli Ganga immediately upstream of the confluence with the Atabaga Oya. (Baker-IVI)
W85-05818

SALLENTE DAM SPILLWAY,
Informes y Projectos S.A., Madrid (Spain).
M. S. Tovar,
International Water Power and Dam Construction, Vol. 37, No. 3, p 33-36, March, 1985. 7 Fig, 6 Ref.

Descriptors: *Sallente Dam, *Spain, *Spillways, Design criteria, Hydraulics, Flow, Model studies, Avalanches, Flip bucket.

Salente dam in Spain has an uncontrolled side spillway with a channel discharge tunnel. Some modifications to the structure had to be carried out following scale model tests, and these are described in this article. The spillway was designed to prevent damage, obstruction and difficulties in the event of avalanches of snow, which frequently occur at this site. The preliminary design has worked correctly for the 1000 year flood. For higher flows operation was affected by the inlet tunnel which produced disturbance and premature flooding. To improve these conditions, the inlet section was widened, easing the inlet's forms, and a center splitter wall was designed. The transition between the vertical and inclined walls of the side channel was eliminated, and its satisfactory hydraulic operation has been proved. The form of the flip bucket, which can modify the direction of the flow, was designed using plane surfaces, rather than the classical solution of cylindrical surfaces; this will facilitate construction. (Baker-IVI)
W85-05820

EXPERIMENTAL INVESTIGATIONS OF THE WORK OF FOUNDATION ELEMENTS OF HYDRAULIC STRUCTURES,
V. S. Adlersberg.
Hydrotechnical Construction, Vol. 18, No. 7, p 297-302, July, 1984. 7 Fig, 3 Tab. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 17-21, July, 1984.

Descriptors: *Hydraulic structures, *Foundations, *Strength, Stress analysis, Dam construction.

Reconstruction and modernization of existing hydraulic structures is inseparably related to the problem of strengthening structural elements. After strengthening, the element should absorb additional loads. When constructing the foundation slabs of hydraulic structures in two phases it is necessary to take into account that the work of the two foundation slabs with the same geometry and same external load can be substantially different if the first of them is constructed and loaded at once and the second was additonally loaded after increasing its geometry. In all foundations being constructed anew it appears possible to substantially reduce the bending moments by redistributing the reaction pressures on the under surface. (Baker-IVI)
W85-05821

8B. Hydraulics

SCOUR CONTROL AT OUTLOOK BRIDGE - A CASE STUDY,
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W85-05454

CHARTS FOR WATER HAMMER IN LOW HEAD PUMP DISCHARGE LINES RESULTING FROM WATER COLUMN SEPARATION AND CHECK VALVE CLOSURE,
British Columbia Univ., Vancouver. Dept. of Civil Engineering.
E. Ruus, B. Karney, and F. A. El-Fitiany.
Canadian Journal of Civil Engineering, Vol. 11, No. 4, p 717-724, December, 1984. 22 Fig, 1 Tab, 8 Ref.

Descriptors: *Pumps, *Pipelines, *Water hammer, *Water column separation, Water distribution, Check valves, Head, Valves.

Water column separation is likely to occur when pumps fail in an unprotected low head installation that has a long pipeline carrying water at high velocity. A systematic study was made combining the effects of water column separation and check valve closure on the maximum pressure head rise, both initiated by power failure. Water column separation occurring in a high point can yield a dangerous pressure head rise in the pipeline. The vertical elevation of the high point has the primary influence on water column separation and on the resulting maximum pressure head rise. Sharp pressure head peaks occured at nearly all high point locations studied. Pressure head rises higher than nine times the initial steady state pumping head can occur in some cases. Very little or no water column separation occurs in the high points considered when low pipeline constant values are combined with high inertia constant values. Water column separation does not always signal a danger for the pipeline. In many cases, column separation only marginally increases the pressure head rise above that produced by check valve closure. The hissing and thumping noise that may occur may be objectionable. Large friction in general reduces the pressure head rise caused by water columnn separation and sometimes eliminates the separation. Low head installations are more susceptible to water column separation than high head installations. (Baker-IVI)
W85-05455

INTERPOLATION OF THE COLEBROOK FORMULA FOR APPLYING THE HARDY CROSS METHOD TO WATER DISTRIBUTION SYSTEMS (INTERPOLATION DE LA FORMULE DE COLEBROOK POUR L'APPLICATION DE LA METHODE DE HARDY CROSS AUX RESEAUX DE DISTRIBUTION D'EAU),
Bologna Univ. (Italy).
G. Rossi.
Houille Blanche, No. 8, p 553-556, August, 1984. 2 Tab.

Descriptors: *Water conveyance, *Friction, *Pressure pipelines, Mathematical equations, Head loss, Hydraulic roughness, Turbulence.

It is first shown that the Colebrook formula for calculating the friction coefficient in uniform movement of a turbulent liquid, in a pressure pipeline, is not easily adaptable to the Hardy Cross method. Attempts were therefore made to find, by interpolation, an equation which would give a good approximation of friction coefficient figures for water at 12 C within the speed, diameter and roughness parameters of interest in water distribution systems, and at the same time would provide monomial expressions of head losses easily applicable with the Hardy Cross method for specific roughness values. (Author's abstract)
W85-05542

FREE JET SCOUR BELOW DAMS AND FLIP BUCKETS,
Gibb (Alexander) and Partners, London (England).
P. J. Mason, and K. Arumugam.
Journal of of Hydraulic Engineering, Vol. 111, No. 2, p 220-235, February, 1985. 4 Fig, 3 Tab, 32 Ref, 1 Append.

Descriptors: *Free jet scour, *Scour, *Dams, *Flip buckets, *Mathematical formulas, Particle size, Chutes, Flumes, Jets.

Formulas proposed to date for calculating ultimate scour depth under jets, such as issue from free dam overfalls and flip buckets, were examined. The accuracies of the formulas were evaluated by using each to process sets of scour data from prototypes and models of such prototypes. Scour depth is as

adequately calculable using only unit flow q and head drop H as using more complex considerations, but those formulas most applicable for model purposes are not those best for prototypes. Where bed particle size d was also considered, the use of the mean particle size dm was more appropriate than the d90 size. Chute friction loss allowances and jet impact angle were also examined in terms of improved accuracy; the relevance of Froude law scaling for this type of scour was verified. A novel formula for predicting ultimate scour depth, which includes an allowance for tailwater depth h, gives improved accuracy for both models and prototypes. (Author's abstract)
W85-05781

DRAG COEFFICIENT ON PYRAMIDAL BAFFLE BLOCKS,
Societe Generale pour l'Industrie Ingenieurs-Conseils, Geneva (Switzerland).
M. Gerodetti.
International Water Power and Dam Construction, Vol. 37, No. 3, p 26-28, March, 1985. 7 Fig, 5 Ref.

Descriptors: *Baffles, *Drag, *Hydraulic jump, Hydraulics, Velocity, Supercritical flow, Scale models, Hydraulic models.

Forces on pyramidal baffle blocks at the downstream end of outlets under spraying supercritical flow conditions depend on a number of factors, for example, water velocity and height of baffles. Some experimental results are presented. The experiments were carried out for complete testing of a dam's hydraulic structures on a 1:50 scale model. For the project in question, pyramidal baffle blocks were placed at the downstream end of the five bottom outlets, which in the model were 150 mm wide and 80 mm high. The flow was measured by an orifice meter in the supply pipe and the depth of the supercritical flow was adjusted by a curved sluice gate. The tailwater level was adjusted according to the natural conditions and did not vary during the tests. The drag force on an individual baffle block was measured with the help of a specially fabricated drag frame. The drag forces were compared with one another and analyzed to correlate the relationship between different parameters. (Baker-IVI)
W85-05819

CALCULATION OF SEEPAGE FROM A RESERVOIR BY THE MATHEMATICAL MODELING METHOD,
For primary bibliographic entry see Field 2F.
W85-05822

NUMERICAL SIMULATION OF TURBULENT FLOWS,
National Aeronautics and Space Administration, Moffett Field, CA. Ames Research Center.
For primary bibliographic entry see Field 2E.
W85-05830

SECONDARY FLOW IN CURVED OPEN CHANNELS,
Universidad Central de Venezuela, Caracas. Inst. de Mecanica de Fluidos.
For primary bibliographic entry see Field 2E.
W85-05831

8C. Hydraulic Machinery

RESERVOIR RELEASE IMPROVEMENT,
Tennessee Valley Authority, Chattanooga. Div. of Water Resources.
For primary bibliographic entry see Field 5G.
W85-05298

EVALUATION OF WATER BLEEDER CONTOLS,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
D. W. Smith, and A. Yee.
Environmental Protection Service, Technology Development Report EPS 4-WP-83-1, March 1983. 60 p, 24 Fig, 10 Tab, 64 Ref, 1 Append.

Descriptors: *Water bleeding, *Freezing, *Pipelines, *Hydraulic equipment, *Subarctic zone, Water conveyance, Water distribution, Pipes, Conveyance structures, Water mains, Economic evaluation, Canadian distribution systems, Bleeder control devices.

Alternative service line bleeder controls that could be used with existing bleeder systems were evaluated for their ability to prevent pipe freezing in northern piped distribution systems. Laboratory scale tests were conducted on five bleeder control devices: a temperature controller, a timer, a gravity flow drainage tank, and orifice plate, and a storage pressure tank. The orifice plate and the variable set timer gave technically acceptable results and are recommended for further development. The orifice plate can regulate continuous bleeder flows to a specified minimum, relieving the bleeder operator of the responsibility of setting flow. The timer showed the greatest potential for saving water because it allowed only intermittent bleeding. The timer also proved to be the more economic of the two alternatives based on a 20-year expected life present worth comparison. (See also W70-01088, W71-06625, and W74-10161)
W85-05301

HYDRAULIC MODEL STUDIES ON BULB TURBINE INTAKES,
Bureau of Reclamation, Denver, CO. Hydraulics Branch.
C. A. Pugh.
Available from the National Technical Information Service, Springfield, VA 22161. Bureau of Reclamation Report REC-ERC-82-14. March 1983, 18 p, 28 Fig, 4 Ref.

Descriptors: *Hydraulic models, *Hydraulic equipment, *Intakes, *Turbines, *Cost savings, *Pressure head, *Hydraulic machinery, Flow velocity, Velocity distribution, Model studies, Construction costs, Rim generator turbine intakes, Bulb turbine intakes, Value engineering.

Intakes for bulb and rim generator turbines are very large in relation to their runner diameters. Because the water velocity is low in the intake area, the losses are small. The effect is described that simplifying the intake design has on energy losses and flow distribution. Various models were employed to test the effect of alterations intake size and shape, and the effects of a bulkhead slot, a pier in the intake, a draft tube, and different approach channel configurations. Using straight surfaces in place of curved bellmouth entrances and shortening the length of the intake could significantly reduce construction costs. In addition, reducing the intake size would reduce the size of trashracks, gates, and associated operating equipment.
W85-05307

PROCEEDINGS OF THE AMERICAN POWER CONFERENCE, CHICAGO, IL, APRIL 18-20, 1983.
Illinois Institute of Technology, Chicago, IL, 1983. Vol 45, 1120 p.

Descriptors: *Powerplants, *Conferences, Water use, Hydroelectric plants.

This proceedings volume contains 168 papers on the generation, transmission, distribution and utilization of power. The papers are arranged in the following categories: mechanical, electrical, nuclear, civil engineering, industrial, water technology, and hydroelectric.
W85-05323

LONG-DISTANCE, HIGH-PRESSURE WATER SUPPLY SYSTEM FOR BONANZA POWER PLANT,
Burns and McDonnell, Kansas City, MO.
R. D. Vering, D. J. Langford, D. J. Miller, and K. M. Neuschwander.
In: Proceedings of the American Power Conference, Chicago, IL, April 18-20, 1983. Illinois Institute of Technology, Chicago, 1983. Vol 45, p 880-884, 2 Fig, 1 Ref.

Descriptors: *Powerplants, *Water conveyance, Pumps, Pipelines, Wells, Diversion Structures, Alluvial aquifers, Computers.

Construction of the water supply system for the Bonanza Power Plant is nearly complete. All systems are scheduled to be fully operational by June of 1983. The special corrosion and water hammer protection considerations incorporated into the system should result in a long life, trouble free pipeline. Several innovative features were included in the design of the Bonanza Power Plant. Field tests have proven the Ranney collector wells to be an effective method of water diversion from shallow alluvial aquifers. Mechanical joint, pretensioned concrete pipe has proven to be a cost-effective, water-tight pipe material for high-pressure, long-distance water pipelines in its first know application in this service. The use of polyethylene encasement effectively shields concrete pipe from impressed currents and allows interference corrosion problems to be solved with resistance bonds. The use of identical pumps for interchangeability allows maximum operation flexibility and reduces maintenance, spare part and capital costs. Pump stations 20 miles from the plant site are controlled with minimal operator input from a plant site control room by utilizing a supervisory communicaitons system and a programmable controller. Multiplexing the control signals significantly reduces communication system cost, and the programmable controller provides maximum flexibility in system control modification.
W85-05328

ANALYSIS AND COMPUTERIZED MODEL OF THE AUTOMATIC HYDRAULIC RAM PUMP,
Ottawa Univ. (Ontario). Dept. of Civil Engineering.
E. J. Schiller, and P. Kahangire.
Canadian Journal of Civil Engineering, Vol. 11, No. 4, p 743-750, December, 1984. 10 Fig, 7 Ref.

Descriptors: *Pumps, *Hydraulic ram pump, *Computer models, Model studies, Pumping, Hydraulic machinery, Water hammer, Automation, Head loss.

The automatic hydraulic ram pump is a unique device that uses energy from a falling quantity of water as the driving power to pump some of the water to a head much higher than the source. The operating characteristics of the hydram system were studied analytically, with some parameters being determined experimentally. The system efficiency, pumping capacity, pump power, and cycle duration were derived with a simple computerized model. The velocity to initiate waste valve closure is identified as the most important parameter controlling hydram operation and is affected by waste valve design and adjustment, supply head, and drive pipe length. With parameters such as velocity of water in the drive pipe when the waste valve begins to close, dimensionless drag force coefficient, total head loss factor of both the drive pipe and waste valve, total head loss factor of both drive pipe and delivery valve, frictional head loss factor of the drive pipe alone, and steady state flow velocity in the drive pipe, determined under steady flow conditions, the performance of the hydram can be predicted within acceptable errors using a simple computerized model. The simple analysis presented gives results in close agreement with the measured pump performance. (Baker-IVI)
W85-05456

DEVELOPMENT OF AXIAL FLOW MACHINES FOR USE IN TIDAL POWER PLANTS (EVOLUTION DES GROUPES AXIAUX POUR L'EQUIPEMENT DES INSTALLATIONS MAREMOTRICES),
J. Bosc, and L. Megnint.
Houille Blanche, No. 8, p 591-595, August, 1984. 2 Fig, 2 Ref.

Descriptors: *Tidal powerplants, *Axial flow, *Hydraulic equipment, Turbines, Powerplants, Electrical equipment, Hydraulic machinery.

Typical tidal power plant sites have a drop in water level of between 0 to 13 to 14 meters. The choice of operating equipment for small differences in water level has a crucial influence on plant productivity; the electrical and mechanical design of such equipment must therefore be properly adapted to these conditions. Based on pilot projects which have proved successful for the Rance and rivers with small differences in gradient, two technical possibilities are worth examination: the use of speed multiplicators; the use of variable speed groups which employ static frequency convertors at full or partial operating capacity. (Author's abstract)
W85-05546

DEVELOPMENT OF AN AUTOMATED PLUGGING FACTOR MONITOR,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
For primary bibliographic entry see Field 3A.
W85-05597

MISCELLANEOUS POWER O AND M INSTRUCTIONS.
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
Power O and M Bulletin No. 27, July 1982. 15 Fig.

Descriptors: *Generators, *Electric powerplants, *Electrical equipment, *Insulation, *Maintenance, *Pipes, *Coatings, *Hydraulic equipment, Electric power production, Electrical transmission, Electrical insulators, Chlorine, Protection, Turbines, Hydraulic machinery.

This bulletin contains a number of unrelated topics of instruction or information not included in other bulletins. Any section may be revised or cancelled if the material is absorbed by another bulletin, and sections may be added. This bulletin contains data from Maintenance Instruction Sheet Nos. 25, 46, 47, and 60, and supersedes them. Topics covered by the thirteen items are: standard transmission line structure numbering system, and standard switch numbering system; generator thrust-bearing insulation, and oil film resistance; load division and circulating current in parallel-operated transformers; test equipment available for loan from the Engineering and Research Center; limitations in manual and automatic synchronizing; an electrical method of moving an alternator rotor; commutator and collector ring performance; fiber optic arc detector; protective coatings for water passage surfaces of turbine scrollcases, turbine parts, and draft tubes; high pressure systems; acceptable generator power transients during switching; and chlorine gas system safety program.
W85-05599

USE OF EQUALIZING RACKS IN THE OUTLET SECTIONS OF DRAFT TUBES OF HYDROELECTRIC AND PUMPED-STORAGE STATIONS,
I. E. Mikhailov, M. F. Gubin, and V. G. Kudrevatykh.
Hydrotechnical Construction, Vol. 18, No. 7, p 308-312, July, 1984. 3 Fig, 7 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 7, p 25-29, July, 1984.

Descriptors: *Pumped storage, *Hydroelectric plants, *Equalizing racks, Flow, Energy, Equalizing basins, Equalizing reservoirs, Draft tubes.

The flow under a runner, especially when operating in nonoptimal turbine regimes, has considerable nonuniformity. The nonuniformity of the flow can be reduced either by eliminating nonoptimal operating regime of the turbine or by installing a flow converter in the outlet section of the draft tube. A plane equalizing rack installed in the grooves of the guard gate can be used as the flow converter equalizing the velocity distribution in the cross sections of the draft tube of a hydroelectric station. Investigations and calculations showed that the installation of equalizing racks in the outlet sections of draft tubes increases the operating efficiency of hydraulic machines and is expedient both in energy and economic respects. To determine the actual positive effect, an equalizing rack should be installed at one of the operating hydroelectric stations or pumped storage stations and the necessary on-site observations and measurements carried out. (Baker-IVI)
W85-05823

8D. Soil Mechanics

TEMPORAL VARIATION OF THE CHARACTERISTICS OF SANDS IN HYDRAULIC-FILL STRUCTURES OF THE RIGA HYDROELECTRIC STATION,
I. V. Dudler, V. V. Malakhanov, A. N. Yulin, A. V. Serkov, and A. Ya. Vinogradov.
Hydrotechnical Construction, Vol. 18, No. 5, p 200-206, May, 1984. 4 Fig, 5 Tab, 8 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 9-13, May, 1984.

Descriptors: *Dam construction, *Sand, *Hydraulic fill dams, Hydroelectric plants, Construction, Design criteria, Riga hydroelectric station, Dams, Levees, Particle size.

When designing hydraulic-fill structures the temporal variations of the characteristics of hydraulic-fill sand caused by processes of infilling of their voids, consolidation, and development of structural bonds are practically disregarded. Increasing the rate of hydraulic filling, compression of the dam profile when necessary, and increasing the permissible rate of reservoir drawdown are processes which substantially increase the strength and dynamic stability of sands and reduce their compressibiliy and permeability. Investigations were made of the hydraulic-fill structures of the Riga hydroelectric station. An analysis of the data of operative construction control of the first years of hydraulic filling of the structure suggested the advisability of introducing a number of corrections in the hydraulic-fill specifications. A somewhat finer sand than was stipulated by the specifications was placed in the dams and levees of the Riga hydrostation. According to the specifications the content of particles smaller than 0.25 mm should have been 20-40%, whereas actually according to the operative control data it was 30-50%. Infilling occurred both during infiltration of water during hydraulic filling of the next layers and during fluctuation of the depression surface during drawdown of the reservoir. The change in the particle-size distribution of sands not only reduces their permeability but also noticeably affects the conditions of formation of the density and strength of the hydraulic fill sands. Consolidation of the hydraulic-fill sands with time leads to an increase of their dynamic stability. (Baker-IVI)
W85-05023

STABILITY OF A PEBBLE DAM WITH AN INJECTED CORE,
L. N. Rasskazov, and A. A. Belyakov.
Hydrotechnical Construction, Vol. 18, No. 5, p 226-233, May, 1984. 4 Fig, 1 Tab, 8 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 26-32, May, 1984.

Descriptors: *Dam stability, *Injected cores, *Earth dams, *Rockfill dams, Dam construction, Canyons, Topography, Slopes, Soil compaction, Stability, Stress, Strain.

The performance of an earth dam is determined mainly by its state of stress and strain, which is substantially affected by the conditions of the three-dimensional behavior of the structure. An investigation of the stress-strain state of a dam can be based on the solution of two- and three-dimensional problems, the combined approach to the investigation consisting of the following: the behavior of the dam determined by its design, the behavior of the dam determined by the topography of the canyon in which it will be constructed, the behavior of the structure as a whole. When it is possible, it is expedient for investigating the behavior of earth dams to use the combined approach based on solving selected two- and three-dimensional problems in a definite way. The three-dimensional behavior of a 122.5 m high gravel dam in a canyon with a site coefficient Ksi about 1 is determined mainly by its interaction with the walls; the dam proved to be substantially underloaded. This can cause development of slide processes in the surface zones of the dam if there is insufficient compaction of the soil. The effect of a change in the slope of the downstream face on stability of the dam is small. Graphs of effect of soil placement density and slope of the downstream face on stability of the first-phase dam can be used when assigning the parameters of the dam design and soil placement density on the basis of known stability requirements. Since in the case of poor compaction of the soil a loss of stability occurs in the surface zones of the dam, near the crest and slopes, stringent requirements should be imposed on soil compaction precisely in these zones. It is also expedient to replace the gravel-pebble fill by fill having a greater strength under small stresses, as by rubble. (Baker-IVI)
W85-05026

FIELD OBSERVATIONS OF RIVER BED SCOUR ON THE PEACE RIVER NEAR FORT VERMILION, ALBERTA,
Research Council of Alberta, Edmonton. Hydrotechnical Section.
R. A. Harrington, and D. G. McLean.
Canadian Journal of Civil Engineering, Vol. 11, No. 4, p 782-797, December, 1984. 15 Fig, 5 Tab, 15 Ref.

Descriptors: *Scour, *Bridges, *Peace River, *Fort Vermilion, *Alberta, Hydraulics, Rivers, Sediment erosion, Mathematical equations, Flow discharge, Velocity.

Field measurements were made of general and local scour at a bridge crossing on the Peace River at Fort Vermilion, Alberta and comparisons of these measurements were made with results from commonly used design equations. The Peace River is the largest sand bed river in Alberta. It exhibits an irregular meandering pattern and is often split by large wooded islands, resulting in a considerable variation in width and depth along the river. Flow regulation provided by the W. A. C. Bennett Dam has significantly reduced summer peaks on the River. Therefore, the probability of obtaining discharge in the range that would be considered channel forming has been reduced. The data indicate that bedform dimensions increased with discharge and that the magnitude of the bedform height could be up to 20% of the general scour magnitudes. Most formulae for predicting general scour at the crossing site were in overall agreement with the measured data, although the Lacey equation is not appropriate, nor was it intended, for locations with a significant degree of contraction. In addition, the mean velocity method was excessively conservative. The local pier scour formulae all overestimated the local scour although this is partly due to the arresting action of the footing on scour development. This phenomenon is due to the site-specific characteristics of the Fort Vermilion crossing. (Baker-IVI)
W85-05457

LONGITUDINAL DISPERSION OF MATTER DUE TO THE SHEAR EFFECT OF STEADY AND OSCILLATORY CURRENTS,
Government Industrial Research Inst., Chugoku, Kure (Japan).
H. Yasuda.
Journal of Fluid Mechanics, Vol. 148, p 383-403, November, 1984. 18 Fig, 9 Ref.

Descriptors: *Dispersion, *Water currents, *Shear, *Oscillatory currents, Fluid mechanics, Boundary conditions, Variance, Mathematical studies.

The longitudinal dispersion in an oscillatory current forming a boundary layer given analytically has been analyzed previously. The earlier analytical method has been expanded to deal with longitudinal dispersion due to the shear effect, making a comparison between that in the steady current and that in the oscillatory current. The time-dependency of the vertically averaged dispersion coefficient has been elucidated analytically in both the steady

and oscillatory currents, regardless of the vertical profile of the current. The dispersion during the initial stage or its variation within one oscillatory period, which has strong vertical shear of the first-order moment, has required a new definition of the variance and the dispersion coefficient. Analysis of the dispersion during the initial stage needs a clear definition of the vertical average of the variance. The problem of the negative dispersion coefficient, which is obtained by the usual vertical average, through introduction of a new vertical average, can be understood. (Baker-IVI)
W85-05469

EXPERIENCE IN THE OPERATION OF HYDRAULIC STRUCTURES AND EQUIPMENT OF HYDROELECTRIC STATIONS,
Yu. A. Zhebelev, and Z. I. Solov'eva.
Hydrotechnical Construction, Vol. 18, No. 7, p 325-330, July, 1984. 3 Fig, 2 Tab, 2 Ref. Translated from Gidrotechnickeskoe Stroitel'stvo, No. 7, p 37-40, July, 1984.

Descriptors: *Earth dams, *Bratsk Hydroelectric Station, Drainage, Seepage, Hydroelectric plants, Settlement, Dam foundations.

The right bank earth dam at the Bratsk Hydroelectric Station is hydraulic fine sand fill and has a crest length of 2965 m, maximum height 36.6 m, crest width 21.7 m, and side slope ratios of the upstream and downstream slopes of 1:4.1:3 and 1:3.1:2.5, respectively. A general picture of settlement along the longitudinal lines of the surface as of May 1983 is given. Since the dam is hydraulic-fill, wetting of the dam with attainment of the normal pool level did not produce considerable consolidation. Settlement on the right bank dam is considerably less than on the left bank. The total settlement of the upstream slope during the period from 1966 through 1983 is from 19 to 85 mm. Settlement along the longitudinal lines formed in complete conformity with the total thickness of the dam body and loose foundation soils, the process of consolidation occurring both in the dam body and in the dam foundation. Settlement is continuing to increase in a particular stretch, apparently due to a decrease of the uplifting effect of groundwaters in connection with lowering of the levels during the period 1976-1982. The overall seepage regime is stable in time. The piezometric levels and discharges are staying within certain limits at the corresponding UPLs. The levels in the piezometers do not exceed the design lines of seepage. The exception is the discharge in collector drain No. 2, which showed a tendency toward an increase in connection with piping into the gallery at DM 46. The presence of two piping centers in the drainage gallery at DM 30 and DM 46 requires greater attention. The installation of flumes with a sand blanket is stopping piping into the gallery, but is not reducing the gradients of the head at the outlet, that is, it is localizing the processes but is not eliminating them. The effect of the constantly acting vibration loads on the dam is unclear. This process may lead to consolidation or liquifaction of the soils, which should be established by constant seismometric observations. (Baker-IVI)
W85-05825

8F. Concrete

FLY ASH AND FLY ASH CONCRETE,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
E. R. Dunstan.
REC-ERC-82-1, May 1984. 42 p, 32 Fig, 11 Tab, 45 Ref.

Descriptors: *Concrete technology, *Cements, *Fly ash, *Pozzolans, *Concrete testing, *Concretes, *Portland cements, *Concrete mixes, Strength, Testing procedures, Calcium sulfate, Minerals, Freeze-thaw tests.

Fly ash is a residue that results from the combustion of ground or powdered coal. Historically, fly ash has been referred to as a pozzolan and is used to reduce the amount of portland cement in concrete. However, in many Western States fly ashes have cementitious properties as well as pozzolanic properties, and they are capable of producing good strengths without portland cement. This study discusses test results of several ashes according to ASTM: C618, (Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete). Many changes are suggested. The replacement of 15 to 25% by mass of portland cement in concrete is examined. A few highly cementitious ashes were used to make concrete without portland cement. A new cement was developed that consists of over 90% fly ash and anhydrous CaS04. Test data for most concretes include: mix proportions, compressive strength, elasticity, drying shrinkage, sulfate resistance, and freeze-thaw durability. Other results included are adiabatic temperature rise, alkali-aggregate reaction, and modulus of rupture. (Author's abstract)
W85-05596

SELECTION OF PLACEMENT TECHNIQUES FOR WATER BOREHOLE CEMENTING,
British Geological Survey, London (England). Hydrogeology Research Group.
N. S. Robins.
Water Services, Vol. 89, No. 1068, p 64 and 68, February, 1985. 9 Ref.

Descriptors: *Boreholes, *Cements, Drilling, Drill holes, Engineering.

Borehole cementing is a specialized and highly technical field of drilling engineering. There are three main uses of borehole cements in the water industry: as a bridge plug, as a backfill medium during construction or abandonment; and as a seal in the annular space between the borehole wall and the casing. The cement slurry used must be capable of setting into a durable solid of sufficiently low permeability to restrict fluid flow and sufficient strength to support the borehole wall and casing. Placement of the cement is carried out by one of two methods - pressure placement or gravity placement. Gravity placement of cement can be carried out by most drilling contractors providing the depth range is only moderate. Pressure cementing is usually undertaken by a cement service company. (Baker-IVI)
W85-05815

8G. Materials

VIBRATION TESTS OF THE ANDIZHAN RESERVOIR BUTTRESS DAM,
G. E. Shablinskii, Yu. A. Simon, V. F. Zakharov, G. A. Shapiro, and F. L. Doronin.
Hydrotechnical Construction, Vol. 18, No. 5, p 207-211, May, 1984. 5 Fig, 1 Tab, 4 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 13-16, May, 1984.

Descriptors: *Andizhan Reservoir Dam, *Buttress dams, *Vibration, *Testing procedures, Karadarya River, Earthquake engineering, Dam construction, Seismic properties, Concrete dams, Gravity dams.

The Andizhan Reservoir Buttress Dam was built on the Karadarya River in a region with intensity 9 seismicity. The height of the dam is 119.5 m; the slopes of the upstream and downstream faces, m = 0.5; the width of the sections is 25 m. After completing construction it was necessary to establish to what extent the investigations conducted on models and the calculation of the earthquake resistance of the dam reflected the actual work of the structure. Determination of the dynamic characteristics of the prototype structure, including a determination of the frequency and models of free vibrations, is necessary for solving this problem. Dynamic tests of concrete dams by the vibration machine make it possible to determine the dynamic characteristics of the structure with a high accuracy and on this basis to refine its calculation scheme. In dynamic calculations for concrete gravity dams it is necesary to take into account the three-dimensional character of behavior of the structure (interaction of the sections) and to estimate the forces occurring in the intersectional joints for checking the strength of the intersectional seals. (Baker-IVI)
W85-05024

USE OF CATHODIC PROTECTION OF BURIED AND SUBMERGED METALS IN CORROSION PREVENTION IN ELECTRIC POWER INSTALLATIONS.
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
Power O and M Bulletin No. 25, March 1983. 17 p, 6 Fig, 5 Ref, 1 Append.

Descriptors: *Corrosion, *Corrosion control, *Metals, *Anodes, *Cathodes, *Coatings, *Protection, *Electric powerplants, Metallurgy, Pipes, Gates, Electrodes, Insulation, Soil water, Electrolytes, Design criteria, Water tanks.

The protection of metallic structures against corrosion damage is considered beneficial from an operating standpoint as well as from the financial aspect for replacement of structural components and labor. The principles of galvanic and stray current corrosion are described. Water or soil water often provides the electrolyte required to complete the cell circuit between metallic anodes and cathodes. Protective coating and cathodic protection complement each other and afford the best protection against corrosion. Cathodic production uses an impressed or galvanic current to reduce or prevent corrosion of a metal in an electrolyte by making the metal to be protected the cathode of a corrosion cell. Sacrificial anodes, metallically connected to a corroding structure and suitably immersed in the electrolyte (water or moist soil), create a simple galvanic cell in which the structure is the cathode or protected surface. In this system detrimental corrosion is replaced by localized and controlled corrosion of an expendable and replaceable anode. Proper designing, spacing and installation of a sacrificial anode system are discussed. Impressed current (rectifier) systems are similar to sacrificial anode systems but rely on an artificial or introduced source of current. Insulated joints utilize isolation and sectionalization of metals to prevent a galvanic cell from being formed. Scenarios of several typical field corrosion problems and possible solutions are listed. Design data questionnaires for corrosivity determination of soils, waters or cathodic protection design are given.
W85-05598

8H. Rapid Excavation

EFFECT OF SHOCK WAVES DURING UNDERWATER BOREHOLE BLASTING,
R. A. Gil'manov.
Hydrotechnical Construction, Vol. 18, No. 5, p 221-225, May, 1984. 6 Fig, 4 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 5, p 22-25, May, 1984.

Descriptors: *Blasting, *Shock waves, *Boreholes, *Underwater, Seismic properties, Construction, Pressure waves, Explosives.

The presently used method of estimating safe distances is based on investigations of the propagation of pressure waves from an explosion of exposed charges and does not take into account the characteristics of the formation and propagation of pressure waves from buried, mainly borehole, charges. As a result of an analysis it was determined that during underwater borehole blasting, initiated in the general case from the surface by a detonating fuse, the total water shock wave is formed by the detonation products of the explosive penetrating into the water (Sh wave), the seismic wave retracted in the water (Se wave), and the wave from the explosion of the DF. The seismic component of the water shock wave (WShW) on the oscillograms corresponds to the first arrivals, since the velocity of seismic body waves in rocks is higher than the propagation velocity of a shock wave in water. On the basis of calculating the energy of seismic waves of normal fragmentation explosions and their refraction at the rock water interface, relationships

were obtained for the seismic component of the WShW. (Baker-IVI)
W85-05025

8I. Fisheries Engineering

TROUT FARMING IN WASHINGTON,
Washington State Univ., Pullman. Coll. of Agriculture.
S. C. Harbell, and R. Carkner.
Cooperative Extension Bulletin No. EB756, March 1981, 18 p. 16 Fig, 8 Tab, 9 Ref.

Descriptors: *Trout, *Fish farming, *Pond stocking, Fish stocking, Ponds, Washington, Estimated costs, Legal aspects, Leaky aquifers, Literature review, Economic aspects, Irrigation.

The basic principles that must be followed in the design, construction, and operation of trout farms in ponds are described. The site must have sufficient area and water supply. The water should be between 50 and 65 F, have a dissolved oxygen content of at least 6 parts per million and above, be free of silt and pollutants, and be within pH 6.5 to 9 range. Various soil conditions and climates are discussed. Species selection and natural vs artificial feeding are also considered. Parasite, disease, and weed control can be maximized by proper design, construction, and operation of the pond. Finally, legal and economic aspects of the trout production are discussed.
W85-05337

10. SCIENTIFIC AND TECHNICAL INFORMATION

10D. Specialized Information Center Services

RUSSIAN-ENGLISH/ENGLISH-RUSSIAN GLOSSARY: PLASTICS IN HYDROTECHNICAL CONSTRUCTION.
Bureau of Reclamation, Washington, DC.
Bureau of Reclamation, Washington, DC. 1984. 143 p.

Descriptors: *Plastics, *Construction, *Hydrotechnical, Glossary, Dictionary.

This glossary evolved from a joint US/USSR study on the use of Plastics in Hydrotechnical Construction of water resource development projects. The joint study was made possible by the US/USSR Agreement on Cooperation in the Fields of Science and Technology, first signed in 1972. Originally, glossaries were prepared in three parts: 1) Plastic Films and Soil Stabilizers, 2) Plastic Piping Systems for Irrigation and Drainage, and 3) Polymer Concrete. More than 700 terms presented here are associated with the engineering specialty of Plastics in Hydrotechnical Construction.
W85-05577

10E. Translations

RUSSIAN-ENGLISH/ENGLISH-RUSSIAN GLOSSARY: PLASTICS IN HYDROTECHNICAL CONSTRUCTION.
Bureau of Reclamation, Washington, DC.
For primary bibliographic entry see Field 10D.
W85-05577

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